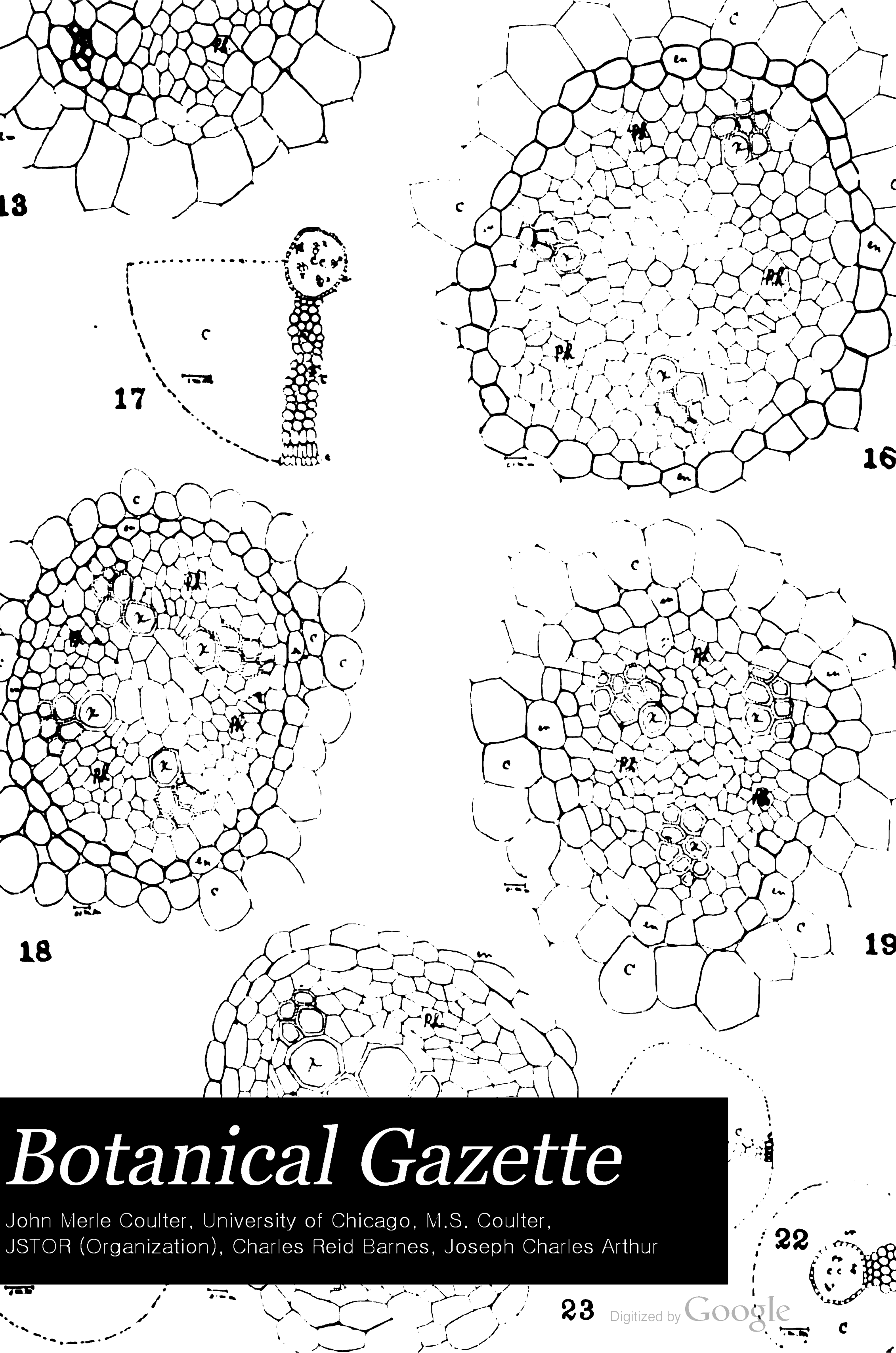

Botanical Gazette

John Merle Coulter, University of Chicago, M.S. Coulter,
JSTOR (Organization), Charles Reid Barnes, Joseph Charles Arthur

THE

BOTANICAL GAZETTE

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ERRATA.

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p. 3, line 11, for "Hemsl." read Moç. et Sess.
p. 3, line 10 from bottom, for "Beleń" read Belén.
p. 16, line 6 *dele* "University of."
p. 43, footnote 2, for "IV" read III.
p. 44, line 3, for "are as" read areas.
p. 47, line 13, *dele* "University of."
p. 102, line 16 from bottom, for "5, 6" read 3, 4.
p. 109, line 13, for "paieful" read painful.
p. 165, footnote 5, for "radicles" read radicales.
p. 189, line 21, for "Lynn" read Lyme.
p. 197, line 10 from bottom, for "Cynophallophorus" read cynophallophora.
p. 200, line 14, for "traclabit" read tractabit.
p. 202, line 13, for "Part." read Pars.
p. 204, line 11 from bottom, for "Migual" read Miguel.
p. 208, line 17, for "ceratopetala" read ceratopetalus.
p. 212, line 11, after seed insert ".
p. 217, line 3, for "Gramneæ" read Gramineæ.
p. 224, line 8 from bottom, for "dlrectly" read directly.
p. 238, line 6 from bottom, for "indespensable" read indispensable.
p. 255, line 11, for "easy" read easily.
p. 255, line 12, for "uredoform" read uredo form.
p. 255, line 4 from bottom, for "cœruleum" read cæruleum.
p. 256, line 4 from bottom, for "underside" read under side.
p. 324, line 2, for "confrére" read confrère.
p. 324, line 13, for "á" read à.
p. 325, line 9, for "conte" read coûte.
p. 326, line 3, for "Whies" read John's.
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p. 328, lines 2 and 5 from bottom, for "form" read split up.
plate XXXVI, for "J. C. A. del." read H. L. R. del.

BOTANICAL GAZETTE

JANUARY, 1893.

Undescribed plants from Guatemala. X.

JOHN DONNELL SMITH.

WITH PLATE I.

Sloanea pentagona (series AXILLIFLORÆ BRACHYSTACHYÆ Benth. Journ. Linn. Soc. V. Suppl. 62).—Ovary excepted glabrous: leaves coriaceous, nitid, entire, oblong ($7–9\times 2\frac{1}{4}–3^{in}$), acuminate, base obtusish, midrib and six to seven pairs of long-ascending nerves salient on both surfaces with distinct transverse veinlets, petioles short (3^{l}): racemes subsessile, suppressed, few-flowered; pedicels incrassate, angular, ($6–8^{l}$), exceeding ovoid alabastra: perianth 4–5-merous: sepals thick, ovate-lanceolate, colored within: petals shorter, lanceolate: stamens bi-seriate, lightly cohering at base, linear anthers thrice exceeding filament, connective mucronate: ovary velvety, pyramidate, concavely 5-angled, prolonged into short simple style, ovules in superposed pairs: developed flowers and fruit not seen.—A large tree with the habit of *Myrodia*, discovered by Baron von Türckheim on his estate at Pansamalá, Dept. Alta Verapaz, alt. $4{,}000^{ft}$, Jan. 1889, (ex Pl. Guatemal. qu. edid. J. D. S. 1,411).

Xanthoxylum foliolosum (§PTEROTA Endl.).—Scandent, armed with short recurved prickles, blotched with exudations, glabrous throughout: leaves 10–15-jugate, rachis narrowly margined and aculeate; leaflets opposite, subsessile, shortly oblong (6×4^{l}), apex round, base truncate and biglandular, coriaceous, veins obsolete above, crenatures glandular, the odd leaflet ovate-oblong and longer, the lower pairs roundish and smaller: panicles axillary and terminal, a third as long as leaves, axes divaricate: sepals triangular, petals thrice longer, gynophore very short, carpids one to two and punctate: coccules one to two, nearly distinct, sessile, globose ($2\frac{1}{2}^{l}$), subequalling pedicels, glandular-tuberculate, endocarp adnate, epidermis of globose seed fleshy.—*X. Pterota* HBK., nearest in habit and technical characters, is distinct by obovate and less numerous

leaflets, long-stipitate and single coccules, etc.—San Rafael, Dept. Zacatepequez, alt. 6,500ft, Febr. 1892, J. D. S., (ex Pl. cit. 1,319.)

Ouratea podogyna (series OOCARPÆ §A, Engl. Fl. Brasil. XII². 302).—Leaves elongate-oblong (12×3in), caudately acuminate, narrowed to short petiole (2—3l), obsoletely serrulate above middle, coriaceous, dull-green above, paler beneath; ascending nerves alone visible, impressed on upper surface, prominent on lower: slender panicle half as long as leaves, pedicels single or geminate and exceeding ovoid-lanceolate buds: sepals atrofuscous, caducous in anthesis, ovate-oblong ($3\frac{1}{4} \times 1\frac{1}{4}$l), the three interior with scarious margins: petals obovate-oblong (4×2l), exunguiculate: stamens equalling sepals, sessile, subulate-tetragonal, lightly rugulose: gynophore slender ($\frac{3}{4}$l), 5-angulate: ovary half as long and twice broader, carpids short-oval and laterally compressed, style equalling petals: drupe not seen.—A tree 15–18ft high, with leaves resembling in form and size those of *O. giganto-phylla* Engl., but with flowers more nearly those of *O. olivæformis* Engl. *O. Guatemalensis* Engl., var. (?) Watson, differs by smaller and membranaceous leaves with close horizontal veins, nearly simple raceme, short and thick gynophore, etc., (no. 39, Watson's Fl. Guat.!)—Pansamalá forest, alt. 3,800ft, Sept. 1886, von Türckheim, (ex Pl. cit. 1,034).

POTENTILLA DONNELL-SMITHII, described by Dr. Focke in BOTAN. GAZ. XVI. 3, is now identified by him as *P. heterosepala* Fritsch, whose publication during the previous year in *Botan. Jahrb.* XI. 314 had been overlooked.—Collected also by Dr. W. C. Shannon, Ass't Surg. U. S. A., associate of the Intercontinental Railway Commission, at Chichoy, Dept. Chimaltenango, alt. 9,000ft, Mch. 1892, (ex Pl. cit. 368); and by Messrs. Heyde & Lux at Chiul, Dept. Quiché, alt. 8,000ft, Apr. 1892, (ex Pl. cit. 3,321).

Fuchsia arborescens Sims, var. (?) **megalantha.**—Lower leaves quaternate: flowers nearly twice larger than in type: the greater stamens exceeding sepals, the lesser equalling style, anthers large ($1\frac{1}{2}$l): stigma minute, ovary ellipsoid.—This is perhaps merely a strongly marked form of heterogonous dimorphism. The typical plant (perhaps only the more fertile form) was distributed as nos. 182 and 2,139 of this series.—Slopes of the Volcan de Acatenango, Dept. Zacatepequez, alt. 7,000ft, Mch. 1892, J. D. S., (ex Pl. cit. 2,469).

Hauya Rodriguezii.—Younger leaves, nerve-axils of the older, and ovaries, cano-pubescent; otherwise glabrate: leaves rhomboid-oval to elliptical ($3\frac{1}{2}$–$4\frac{3}{4} \times 2$–$2\frac{3}{4}^{\text{in}}$), abruptly acuminate, obtusely or acutely angled at unequal base, eight to nine lateral nerves ascending straight to marginal arches: flowers large: lobes of calyx equalling tube ($2\frac{1}{2}$–3^{in}), prolonged to subulate tips: petals two-thirds as long, oval: awns of anthers filiform ($2\frac{1}{2}^{\text{l}}$): style equalling petals, stigma globose (4^{l}): capsule subsessile, large (2–$2\frac{1}{4}^{\text{in}}$), smooth, valves plane.—Compared at Kew by Mr. Hemsley with the originals of described species, and not identified. *H. elegans* Hemsl., as represented in this series of plants by nos. 2,527 and 2,528 determined by that gentleman, is a closely related species, differing chiefly by velvety or sericeous indument, round-oval leaves abruptly short-acuminate and with a rounded or subcordate base, relatively shorter calyx-lobes and longer petals and style.—A tree with a stout trunk, 30^{ft} high.—Acatepeque, Dept. Zacatepequez, alt. $4,300^{\text{ft}}$, Mch. 1892, J. D. S., (ex Pl. cit. 2,529). Named for Sr. lcdo. Don Juan J. Rodriguez, former Minister of the Interior, a distinguished student of *Lepidoptera*, in memory of hospitable and courteous attentions during my sojourn on his estates of Capetillo and Acatepeque situated on the southeastern slopes of the Volcan de Fuego.

Hauya Heydeana.—Arborescent (18^{ft}), glabrous: leaves conterminously lanceolate ($3\frac{1}{2}$–$4\frac{1}{2} \times 1$–$1\frac{1}{4}^{\text{in}}$), tipped with a gland, blotched with exudations: flowers small for the genus ($2\frac{1}{2}$–$2\frac{3}{4}^{\text{in}}$), peduncles twice to thrice longer than petioles (12–18^{l}): lobes of calyx shortly tipped, narrowly linear, exceeding tube: petals as long, twice broader, lanceolate: stigma ellipsoid: capsule about an inch long with narrow (2^{l}) and plane valves.—A well marked species as respects both foliage and flowers, and especially distinct by the peduncle exceptional for the genus.—Beleú, Dept. Alta Verapaz, alt. $5,000^{\text{ft}}$, Apr. 1892, Heyde & Lux, (ex Pl. cit. 2,935).—Dedicated to Sr. pbro. Don Enrique Th. Heyde, parish priest in Santa Rosa, as a slight but very sincere acknowledgment of my obligations to him for an extensive series of plants with duplicates, collected by him and his nephew, Don Ernesto Lux, in the departments of Quiché, Santa Rosa and Jalapa. Important additions to our knowledge of the Guatemalan flora may be expected from the further explorations, proposed by these gentlemen, of regions unknown to botanists, difficult of access,

and inhabited by indigenous races unfriendly to all strangers save such as visit them under the auspices of the church.

Parathesis micrantha. (*Ardisia micrantha* Donnell Smith BOTAN. GAZ. XIV. 26; not of HBK.).—In transferring this species to what recently received material shows to be its correct genus, the specific name preoccupied in *Ardisia* may stand in *Parathesis*, and indicates a character, alike abnormal in both genera, of minute cordate anthers. The bractlets are also seen to be oblong and ciliate.—San Miguel Uspantán, Dept. Quiché, alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,020).

Bumelia pleistochasia.—Leaves smooth and shining, coriaceous, elliptical (3–$3\frac{1}{2} \times 1\frac{1}{4}$–$1\frac{1}{2}^{in}$), obtusely acuminate, base acutely contracted into petiole (4–5^{l}): fascicles densely flowered, equalling petiole: calyx obconic, as long as pedicel, incrassate segments round-ovate: appendages of corolla lateral, obliquely lanceolate, denticulate; proper lobes twice longer, oval, subentire: staminodes half the size of lobes, oval, fimbriate; ovary glabrous.—San Lucas, Dept. Zacatepequez, alt. 5,500^{ft}, Apr. 1890, J. D. S., (ex Pl. cit. 2,184), distributed as *B. persimilis* Hemsl.—Palmer's no. 1,123 Fl. Mex. has been referred more correctly to that species by Mr. J. N. Rose, assistant botanist to the U. S. National Herb. With somewhat similar leaves it differs from the above by pubescence, smaller fascicles of less congested pedicels, cylindrical half-smaller calyx, oblong sepals, elongate lobes of corolla, nearly as long lanceolate staminodes, pilose ovary, etc.

Bumelia leiogyna.—Arborescent and spinose like the preceding, glabrous except the younger parts: leaves membranaceous, veinage distinct, elliptical-oblong to lanceolate ($2\frac{1}{2}$–3×1^{in}), apex obtusish, tapering acutely to short petiole: flowers minute (2^{l}), subequalling pedicels and petiole, 6–10-fasciculate: calyx ovoid, half as long as pedicel; segments ovate with scariose margins, the interior ones puberulent: lobes of corolla obovate, denticulate, patent; appendages minute, subulate from an oval and lacerate base: staminodes also minute, rhomboidal, fimbriate: ovary glabrous, style shortly subulate.—The descriptions of *B. ferox* Cham. et Schl. indicate the nearest affinity, but ascribe to it opaque smaller and more generally obovate leaves, spatulate-lanceolate staminodes; and the ovary may be presumed to be normal and therefore hirsute.—Capetillo, Dept. Zacatepequez, alt. 4,500^{ft}, Mch. 1892, J. D. S., (ex Pl. cit. 1,451).

Styrax conterminum.—Indument leprous, nowhere stellate, scales lacerate, ferruginous on branchlets petioles and calyx: leaves elliptical-oblong ($5–6 \times 1\frac{3}{4}–2^{in}$), conterminously acuminate, long-petiolate ($9–11^{l}$), coriaceous, scales of upper surface sparse, of lower continuous and silvery sprinkled with red: racemes chiefly simple, twice exceeding petioles; flowers large (7^{l}), pedicels as long and minutely bracteolate at base and middle: corolla silvery, thrice exceeding the minutely toothed calyx: filaments half-connate, twice longer than the short (2^{l}) and oblong anthers, exbarbate within, their exterior beset with fimbriate scales.—The other three species of the lepidote group, all South American, can be distinguished by their leaves: in *S. ovatum* A. DC. ovate-lanceolate (838 Rusby Fl. S. Am.! 467 Bang Pl. Boliv.!): in *S. cordatum* A. DC. cordate-ovate: in *S. leprosum* Hook. et Arn. obovate-oblong and small (II. 46 ex herb. Regnell.!). —A small tree; San Miguel Uspantán, Dept. Quiché, alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 2,915).

Ehretia Luxiana.—Branchlets and axes of inflorescence angulate, beset with linear red lenticels: leaves tuberculate at their axils, glabrous, oval with obtuse ends or elliptical with somewhat acuminate apex and more acute base ($2\frac{1}{4}–4\frac{1}{4} \times 1\frac{1}{2}–2\frac{1}{4}^{in}$), serrate above middle: panicle terminal, shorter than leaves, corymbose, densely flowered, slightly pubescent: flowers among the smallest of the genus (3^{l}): calyx a third as long, campanulate, broadly and obtusely lobed to middle: lobes of corolla exceeding tube, oblong, revolute.—Habit and inflorescence are those of *E. Mexicana* Watson (3,085 Pringle Fl. Mex.!), which differs by hispid lanceolate leaves, and still smaller flowers with sharply partite calyx and shortly lobed corolla.—Arborescent (15^{ft}). Called by the Indians "Pepi Nanci."—San Miguel Uspantán, alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,065).

Juanulloa Sargii (§ EUJUANULLOA Dun. in DC. Prodr.). —Leaves membranaceous, glabrate above, sprinkled beneath with stellate pubescence, obovate to rhomboidal or elliptical ($5–7 \times 2–4^{in}$), apex rounded, base cuneate, petioles short (3^{l}) and tomentose: peduncles axillary and terminal, elongated ($3–5^{in}$), forking, coriaceous flowers racemose on dichotomous flexuose axes of panicle: calyx ochraceous-tomentose, red within, campanulate, contracted into short ($3–4^{l}$) pedicel; partitions elliptical-oblong ($10 \times 3\frac{1}{2}^{l}$), acute, two-thirds coher-

ing, in fruit separating: corolla more than twice longer, inflated above middle, aureate-pubescent, red within: anthers linear (6^l), more than half as long as filament: berry globose-ovoid (10^l), seeds oblong and foveolate.—A sarmentose shrub $4–5^{ft}$ high, with foliage crowded toward ends of the short branchlets, scarred with verrucose articulations of fallen leaves and flowers.—Banks of a brook near Escuintla, Dept. Escuintla, alt. $1,100^{ft}$, Mch. 1892, J. D. S., (ex Pl. cit. 1,467). —The name proposed is that of my esteemed friend, Mr. Francis C. Sarg, consul of the German Empire for Guatemala, an accomplished naturalist, who has contributed valuable material to the entomological volumes of *Biologia Centrali-Americana.*

Explanation of Plate I.—Fig. 1, flowering branch. Fig. 2, fruiting panicle. Fig. 3, flower exposed with corolla removed. Fig. 4, corolla laid open. Fig. 5, pistil. Fig. 6, fruit. Fig. 7, seed. (Figs. 1–4 are natural size; the others are variously magnified.)

Tynanthus Guatemalensis.—Undeveloped leaves, axes of inflorescence, and corolla, cano-furfuraceous: leaves nearly glabrous, twice exceeding common petiole, seldom cirrhose; leaflets more usually three, long-petiolulate ($6–11^l$), elliptical ($2\frac{1}{4}–3 \times 1^{in}$), caudately acuminate, apex blunt, membranaceous, the terminal the greatest, with half-longer petiolule and an acute base, the lateral obliquely rounded at base: thyrsi terminal and geminate or becoming axillary, shorter than leaves, primary axes brachiate, of cymules rectangular-divaricate and capillary, bractlets minutely subulate: calyx campanulate, transversely truncate, teeth and nerves obsolete: corolla more than thrice longer ($3–3\frac{1}{2}^l$), white, labiate to middle, furfuraceous lobes of reflexed anterior lip orbicular and unequal, elsewhere within glabrous: stamens and minute ($\frac{3}{4}^l$) inappendiculate staminode equally inserted near base of tube, glabrous: ovary conic, cano-hirsute: capsule not seen.—According to Prof. Bureau's grouping of other species, all South American, this is to be collocated with *T. Goudotiana* Bur., which is distinguishable by an obliquely truncate calyx with a large posterior tooth.—Climbing over trees and flowering profusely.—Banks of Rio Ocosito, Dept. Quezaltenango, alt. 250^{ft}, Apr. 1892, J. D. S., (ex Pl. cit. 1,488).

Schlegelia cornuta.—Epiphytal, procumbent, branches scabrid with setose tubercles and pilose: leaves obovate ($2\frac{1}{2}–4\frac{1}{4} \times 1\frac{3}{4}–2\frac{1}{2}^{in}$), apex rounded or retuse, tapering to short petiole,

thick-coriaceous, smooth and shining, margins revolute, nerves few and robust: peduncles axillary, short ($3-6^{l}$), pilose; pedicels 3–7-fasciculate, half or two-thirds as long as flowers: tube of calyx obpyramidate, pentagonal, lobes twice longer ($4-5^{l}$) and subulate by conduplicately cohering margins: corolla evenly cylindrical ($15-17 \times 2\frac{1}{2}^{l}$), throat scarcely ampliate, lobes subequal (2^{l}): stamens included, twice exceeding staminode, insertion barbate, anthers reniform by diverging oval cells: disk none: berry depressed-globose (4×5^{l}), fleshy; seeds ten to twelve, scariose-alate, enveloped in fibrose pulp.—A pseudo-parasitic shrub, not repent.—San Miguel Uspantán, alt. 8,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,044).

Ægyphila falcata.—Branchlets tetragonal, thickened at nodes, smooth: petioles brachiate, canaliculate, short ($6-9^{l}$); leaves chartaceous, nitid, faintly punctate, oval ($7-9 \times 4-5^{in}$), the younger ovate-oblong, each end broadly rounded and abruptly short-acuminate, falcate, base conduplicate, midrib salient beneath, costal nerves robust: axillary cymes half-equalling leaves and long-pedunculate, the terminal thyrsoid and brachiate, nodes complanate, foliaceous bracts lanceolate, axes fastigiate, bractlets subulate: flowers 4-merous, subdiclinous, dimorphous, puberulent, shortly pedicellate: calyx obpyramidate, mouth nearly truncate: corolla reddish-yellow, hypocraterimorphous, narrow tube one to four times as long as calyx, limb ampliate ($2\frac{1}{2}^{l}$), stamens all more or less polleniferous, the semi-abortive included in short corolla, the others twice exceeding elongate corolla.—A symmetrical tree 30–40^{ft} high, with a habit other than that of *Æ. elata* Swz. by its foliage and abundantly axillary inflorescence, and with the dimorphous flowers of *Æ. arborescens* Vahl.—Escuintla, alt. 1,100^{ft}, Apr. 1890, J. D. S. (ex Pl. cit. 2,111), distributed as *Æ. elata* Swz.: San Felipe, Depart. Retalhuleu, alt 2,000^{ft}, Apr. 1892, J. D. S., (ex Pl. cit. 1,479).

Baltimore, Md.

A comparative study of the roots of Ranunculaceæ.

FRED B. MAXWELL.

WITH PLATES II–IV.

I. Historical Introduction.

After the beginning of the present century, when plant anatomy began seriously to attract the attention of botanists, the cell wall was the first subject of investigation; then the actively growing parts above ground; and finally the roots of plants were studied. Nevertheless the latter have received far less attention proportionally than the other organs of plants.

In reviewing the history of the microscopic investigation of roots the development of the subject appears in two distinct periods.[1] Previous to 1865 anatomists such as Mirbel, von Mohl, and Trecul, studied the various masses of tissues making up roots, and the cells composing them. Since 1865 study has been more directed to the origin of organs and the various parts of organs. Among the more important writers of this period are Nägeli, Hanstein, Reinke, Janczewski, Treub, Erickson and Flahault.

The first period dealt with the histological elements in and for themselves, the second went farther and sought their origin and development; the first mainly investigated mature organs, the second took up the study of the young and newly formed parts, the meristem, especially in their relation to the formation of the mature parts.

In 1810 Mirbel,[2] the earliest of the important writers of the first period, studied the roots of *Nymphaea lutea*, and in 1831 Hugo von Mohl,[3] from the study of the roots of a palm, made the distinction between the central cylinder, cortex, and epidermis. Trecul,[4] among other histological articles published one in 1846 concerning the origin of roots.

Although in time belonging to the second period, I will refer here to a series of articles by Van Tieghem, since these

[1]For the résumé of the works of the earlier writers I am indebted to the admirable articles by Flahault, Janczewski and Olivier.

[2]Examen de la division des vegetaux en endorhizes et exorhizes. Comptes rendus, Oct. 8, 1810. Ann. du Museum, XVI.

[3]De Palmarum structuro.

[4]Recherches sur l'origine des racines. Ann. des Sci. Nat. III. v. 340.

articles dealt more with general plant anatomy than with meristematic structure, the first article[5] dealing particularly with root structure. After stating that certain arrangements of tissues are only found in certain organs, he takes up each organ and studies the modifications of the fundamental structure for that organ, as found in the various classes, orders, genera, etc., of plants. He points out the distinction between root and stem structure, as based on the arrangement of the fibro-vascular bundles, the former normally having radial bundles, the latter collateral ones, though older roots of dicotyledons take on an arrangement similar to the stem structure. He was not the first, however, to call attention to the change taking place in the roots of dicotyledons, since Nägeli as early as 1858[6] had shown that the older roots of many dicotyledons possessed a different structure from the younger roots of the same plant, and that the condition of the younger roots of dicotyledons was the permanent condition of the roots of monocotyledons.

The first important generalization concerning meristem structure to receive immediate consideration of other workers was made by Nägeli and Leitgeb.[7] They found that in vascular cryptogams the several zones of tissues of both stem and root were derived from a single apical cell situated in the vegetative point. All vascular cryptogams studied showed this structure, and they assumed that phanerogams would present a similar development at the growing point, and in young roots they asserted that all the tissues could be traced to a single apical cell as their origin, but in older roots later growth concealed this primary structure. Before this time Otto Nicolai[8] had said that the vegetative point in phanerogams was a group of cells, which, by means of successive division, formed on one side the root cap and on the other the body of the root.

In 1868 Hanstein[9] declared that in phanerogams, the initial at the vegetative-point is never of a single cell, but of a

[5] Ann. des Sci. Nat. V. XIII.

[6] Sur l'accroissement de la tige et de la racine dans les plantes vasculaires. Beitræge zur wissensch. Bot. 1858.

[7] Entstehung und Wachsthum der Wurzeln. Beitræge zur wissensch. Botan. 4, 138.

[8] Das Wachsthum der Wurzel, 1865.

[9] Die Scheitelzellgruppe im Vegetationspunkt der Phanerogamen. Bonn. 1868.

group of cells, and added that the root-cap was from sister cells separated from the epidermis. To the meristematic epidermis he gave the name of dermatogen. In 1870[10] he confirmed this first assumption in a paper, the conclusions of which were quite generally accepted at the time. According to him the cortex and central cylinder each has an initial group of its own, and the root-cap is derived from the epidermis, one being able to trace it for a certain distance under the root-cap. He completely exploded Nägeli's theory of a single apical cell for phanerogams, but he fell into an error similar to Nägeli's in supposing that all phanerogams followed the type explained above. Hanstein was followed by a pupil of his, Reinke[11], who, by the study of mature roots, confirmed Hanstein's conclusions, Hanstein's studies having been made on the roots of embryos. Although Reinke examined but few roots, and all of those of angiosperms, he held that all phanerogams had the structure of the one species especially examined, that is *Helianthus annuus*. Reinke admitted some variations from type, but held that these were not of enough importance to found a new type.

Prantl[12] opposed Reinke's general statement, saying that in maize the epidermis was distinct from the root-cap, possessing an initial group of its own, and in Pisum and Vicia he found that the primitive tissues were confluent at the vegetative-point. In a short note[13] Reinke had already admitted that in *Pinus pinea* the root-cap was not from the dermatogen, but from the periblem, or perhaps that the root-cap was absent and that the cortex served its purpose, being thrown off and developing again.

About the same time Strasburger[14] published a memoir in which he held that all *Coniferæ*, *Gnetaceæ* and *Cycadeæ* have the structure made out for *Pinus pinea*. Reinke admitted that this was probably true. The appearance of doubtful cases has made uncertain the acceptance of Hanstein and Reinke's theory of one type of meristem structure for the roots of all

[10] Die Entwicklung des Keimes der Monocotylen und Dicotylen. Botan. Abhandl. aus d. Gebiete der Morphologie und Physiologie. I. Bonn. 1870.

[11] Untersuchungen über Wachsthumgeschichte und Morphologie der Phanerogamenwurzel. Botan. Abhandl., etc., III, 1871.

[12] Regeneration der Vegetationspunktes an Angiospermenwurzeln. Arb. des Bot. Instituts Würzb. 4, 1874.

[13] Bot. Zeit. 1872.

[14] Die Coniferen und Gnetaceen. Jena 1872.

phanerogams and it only needed Russow's[15] article to prove that this type was not a universal one. Mainly through the study of embryos he compared the roots of phanerogams with those of vascular cryptogams. He found that the roots of all phanerogams did not follow the Helianthus type, for in the embryos of several *Leguminosæ* and in many older roots of dicotyledons one could not trace the epidermis under the root-cap, on the contrary the dermatogen entered the primary meristem of a continuous layer; and he found that in many roots there was no distinction between the dermatogen and the periblem, or between the dermatogen and calyptogen, and sometimes the periblem and plerome were not distinctly separated.

In 1874 appeared Janczewski's[16] very important memoir. He reviewed the work that had preceded his, especially criticising Reinke, asserting that he endeavored to prove a preconceived conclusion, and that his investigations were not sufficiently accurate and extended to base important deductions upon. In making his investigations Janczewski studied the roots of embryos, developing roots, and mature roots, the best results being obtained from the study of the latter, and he bases his conclusions upon this study. He proposed five principal types of meristem structure at the growing-point in the roots of phanerogams. His five types are as follows:

First type, roots having four independent primary tissues at the vegetative point, and so four initial groups, a calyptrogen, a dermatogen, a periblem and a plerome. He placed but two plants in this type, *Hydrocharis* and *Pistia.*

Second type, roots having three independent primary tissues, a sharply defined calyptrogen and plerome, and between these an initial group from which arise the cortex and epidermis, or perhaps no true epidermis present, the outer layers of the cortex taking its place. This is the type to which he assigns most of the monocotyledons.

Third type, roots with three primary tissues, the plerome and periblem being sharply defined but the epidermis and root-cap having a common origin. Here he would include most dicotyledons.

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[15] Vergleichende Untersuchungen, etc., der Phanerogamen, ausgehend von der Betrachtung der Marsiliaceen. Mém. Acad. de St. Petersburg, VII. xix (1872).

[16] Das Spitzenwachsthum der Phanerogamenwurzeln. Bot. Zeit. 1874.
Recherches sur le developpement des radicelles dans les Phan. Ann. des Sci. V. xx.

Fourth type, root with but one primary tissue at the vegetative point, the initial groups of all tissues being confluent, or perhaps we should say possessing a common initial group for all the tissues. Example, some *Cucurbitaceæ* and *Papilionaceæ*.

Fifth type, roots with two primary tissues, the plerome and periblem being distinct, and the outer layers of the cortex serving the purpose of an epidermis and root-cap. To this type belong the gymnosperms.

It will be seen that the first four types pertain to angiosperms and the last to gymnosperms, while the first two includes monocotyledons, and the third and fourth dicotyledons. Hanstein and Reinke's general type is Janczewski's third type, while the fifth type confirms Reinke and Strasburger's work on gymnosperms.

Hegelmaier[17] from the study of embryo roots, would add at least two other monocotyledons to Janczewski's first type. He says that at a very early stage the root-cap is formed by tangential division from the dermatogen, and later growth is by centripetal division of this layer and not from the dermatogen.

In 1876 two important articles upon meristem structure appeared. Treub, from a study of the roots of monocotyledons,[18] would make three types of terminal meristem structure for them, retaining Janczewski's first type and dividing the second into two others. Erickson,[19] from a similar study of dicotyledons would make four types of meristem structure for them. His types are as follows:

First type, roots having three well marked meristem tissues at the vegetative point, a plerome, a periblem, and combined dermo-calyptrogen layer, from which both the epidermis and root-cap arise. This is Janczewski's third type.

Second type, but two well marked meristem tissues in the root, a distinct plerome and a common initial for the cortex, epidermis and root-cap. In this type Erickson places several *Malvaceæ* and scattered species from other groups.

Third type, a common origin for all the tissues, the initial of all the groups coalescing. This is Janczewski's fourth type.

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[17]Zur Entwicklung monocotyl. Keime, etc. Bot. Zeit. 1874.

[18]Le meristeme primit. de la racine dans les monocot. Leyden, 1876.

[19]Ueber das Urmeristem der Dicotylenwurzeln. Jahrbücher für wissensch. Botan. Leipzig, 1877.

Here Erickson includes most of the *Leguminosæ* and a few species from several other groups, including all of the *Ranunculaceæ* which he examined, though saying that these differed from the type in that the periblem developed centrifugally instead of centripetally.

Fourth type, roots having but two well marked meristem tissues, a plerome and a periblem, the outer layers of the cortex answering to the epidermis and root-cap. This agrees with Janczewski's fifth type which he made for gymnosperms.

In an article published in 1878[20] Flahault discusses the theories of structure of the root at its vegetative tip. He thinks that it was on account of Hanstein and Reinke not understanding the early separation of the calyptrogen from the dermatogen that they placed monocotyledons in the Helianthus type. After making a study of the roots of three hundred and fifty species, representing nearly all of the natural orders of plants, he makes two types of primary meristem for angiosperms, one for dicotyledons and one for monocotyledons, distinguishing the two types by the latter always having a distinct calyptrogen layer. The other types as made out by Janczewski and others he would regard as but forms of these two, for between them are all manner of gradations, while the two main types are very distinct.

Fleischer[21] found that in a *Juncus* and *Luzula* the root-cap had an origin of its own while other plants he studied conformed to the Helianthus type. Bruchman claimed to have made out four primary meristem tissues in the roots of grasses which he studied, but did not give details of work or results.

Thus we see that later workers agree that Hanstein and Reinke's assumption of one type of meristem structure for all phanerogams was untenable. As to how many types there are opinions differ widely.

M. Halle[22] tried to reduce Janczewski's two types for dicotyledons to one type, and adds a number of species as belonging to the Helianthus type. He considered Janczewski's fourth type the result of degeneration through excessive development at the vegetative point. He made careful studies of the embryos of many *Leguminosæ*, said to belong to this

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[20]Recherches sur l'accroissement terminal de la racine chez les phanerogams. Ann. des Sci. Nat. VI. vi.

[21]Beitræge zur Embryogenie der Monokotylen und Dikotylen. Flora, 1874.

[22]Bot. Zeit. 1876 and 1877.

fourth type, and found that in this stage they followed the Helianthus type and only later were the initial groups merged into one. Hence he would not consider this as a distinct type. He also points out divergencies from type structure in the roots of other plants, and considers Janczewski's first type but a variation of the second, since he thinks in the roots of *Vallisneria spiralis* he found an intermediate form between the two types. He agrees with Russow that the root must be studied in all stages of development before we can arrive at safe conclusions.

Flahault says of Halle's paper that it furnished important conclusions, but that the number of species studied were too few and the reasons given were not sufficient to put a stop to all discussion, and after his own more extended studies he arrives at about the same conclusion and would make but two general types of meristem structure for the roots of angiosperms.

In 1877 De Bary[28] made a résumé of the work accomplished on the meristem of roots. After discussing the work of various authors he asks, "If the organization of the different systems of tissues, and the structure of the organs ought to be considered as connected with the organization of the terminal meristem, and also if each tissue always takes its birth in the same part of the primary meristem." After reviewing the principal modifications of the structure of the vegetative point of the root, he says, "Determined zones of meristem are not always to be considered as the origin of determined tissues, although it might be so in many cases."

While the résumé which we have made shows us that much has been done in investigating the structure of the vegetative point of roots, it also shows us that there is much confusion as to the types of structure which should be recognized, which confusion can only be cleared up by a careful study of the roots of all the natural orders of plants.

I have undertaken to make a study of the roots of the native *Ranunculaceæ*, especially as to the meristem of the vegetative point, but also somewhat as to the general histological structure of the root. The results of this study will be found in parts II and III of this paper, but before taking up that study the following résumé of work already done on the roots of this order may be found useful.

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[28]Vergleich. Anat. der Vegetationsorgane, etc.

Having had access only to reviews of many of the earlier articles referred to in this paper, I cannot say whether some of them may not have worked upon this group, but the titles of their papers would indicate that many of them had not done so. Of the more important articles which I reviewed I find that neither Van Tieghem nor Janczewski appears to have included any of the *Ranunculaceæ* in their studies. Erickson, as already referred to, studied the roots of several of the *Ranunculaceæ*, among them being *Ranunculus repens*, of which he gives a figure of the meristem, and *Caltha palustris*. Flahault, in his article published in 1878, refers to the structure of the roots of several of this order, and he agrees with Erickson that the tissues merge into one at the vegetative point, but would say that this was but a modification of the general type for dicotyledons. He figured the root tip of *Pæonia officinalis* and *Aconitum pyrenaicum*. Hegelmaier, in an article on the growth of the embryo in dicotyledons, treats at length of several *Ranunculaceæ*, but gives slight reference to the root structure, and does not dwell on the meristem of the growing-point. Olivier[24] treats mainly of the histological structure of roots and places *Ranunculaceæ* in a class of plants in which the secondary vascular tissue appears very late, adding that in the roots of the genus *Ranunculus* there is less secondary vascular development than in any other dicotyledon. He says of the genus *Thalictrum* that the secondary growth appears late, and but very little developed, that the cortical parenchyma is often nearly all exfoliated, the endodermis being persistent and then serving the purpose of an epidermis. De Bary discusses the root structure of several of the *Ranunculaceæ*, and gives figures of the cross-section of the root of *Ranunculus fluitans* and *R. repens*. P. Marie[25] gives an important article on the histological structure of *Ranunculaceæ*, referring to the general histological structure of the roots as well as to that of the stem, etc., but he does not refer to the meristem structure. He gives many good figures of root structure.

Prof. Hargitt[26] published a short article in the BOTANICAL GAZETTE, in which he describes the structure of the roots of *Isopyrum biternatum*.

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[24]Recherches sur l'appareil tegumentaire des racines. Ann. des Sci. Nat. VI. II.

[25]Recherches sur la structure des Ranonculacees. Ann. des Sci. Nat. VI. xx.

[26]BOTAN. GAZETTE xv (1890). 235.

Thus we see that work upon the roots of this order, especially as to the meristem, has been very limited. In the parts of this paper which follow I have endeavored to point out certain types of structure, as I have found them in the roots of the native species of *Ranunculaceæ*.

University of Chicago.

Method for obtaining pure cultures of Pammel's fungus of Texas root rot of cotton.[1]

GEO. F. ATKINSON.

It is not a very difficult matter to obtain artificial pure cultures of spore producing fungi which grow readily in artificial nutrient media. But when we meet with forms of fungi, the spore production of which is unknown, quite a serious difficulty is encountered since spores of other fungi, as well as numerous bacteria, are so apt to be securely lodged in the strands of the mycelium. This serious difficulty is increased when the fungus in question shows a decided aversion to growing on the usual artificial media. The fungus of Texas root rot of cotton, described by Pammel in Bulletin no. 7 of the Texas Agricultural Experiment Station, has not yielded to the methods usually resorted to in obtaining pure cultures.

After trying various methods Pammel failed to obtain a pure culture. In one case threads of the fungus were swept with a camel's hair brush with the hope of obtaining spores. A "pure culture of some fungus" was obtained but its morphological characters were unlike those of the fungus found on the roots of cotton.

During the summer of 1891, at Auburn, Ala., I made several attempts from fresh material received from Texas to induce the fungus to part its hold on the cotton roots and grow under my care and observation. All attempts at that time failed. Affected roots were placed on sand in moist chambers and the fungus strands grew in several cases from four to six inches out over the surface of the sand. When portions of these strands were transferred to nutrient media they failed to grow.

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[1]Paper presented before the Botanical Section of the Am. Assoc. Agr. Coll. and Exp. Sta. New Orleans, Nov. 16, 1892.

In the summer of 1892 I undertook the work again since my labors in the south were soon to end and I was very anxious to obtain a pure culture of this extremely interesting and important organism. I was well supplied with fresh material which was being received once or twice each week.[2] Most of the roots were sent by Mr. R. D. Blackshear, to whom I am especially indebted for the patience and care manifested in gathering and shipping the specimens. Each root was wrapped separately with moist paper retaining a small portion of the earth next it, and several such roots then bound into a single package. They were usually received two days after being removed from the ground. While the roots were en route I prepared several large moist chambers in the following way: A layer of sand about one-half inch deep was placed in the lower vessel and covered with four thicknesses of filter paper. The sand and paper were then well moistened with distilled water, the cover placed in position, being elevated somewhat from the rim of the lower vessel by two tufts of moist cotton to allow free movement of air and steam, this precaution being necessary to avoid breaking the glass while being sterilized. The moist chambers were then piled in a large dry oven, the temperature of which was raised to 140°C. for an hour or two on two successive days. The filter paper was first perforated in several places to prevent its being raised from the sand by steam. When sterilization was complete the tufts of cotton separating bottom and cover were removed.

On receipt of the roots they were carefully unwrapped, the earth removed, the roots rinsed with distilled water, cut in sections about 5^{cm} long and placed horizontally on the filter paper, four or five sections in each moist chamber.

In two or three days the strands of the *Ozonium* could be seen growing out over the filter paper for 4^{cm} to 6^{cm} away from the root. The strands were examined microscopically to determine the fungus. Sterilized glass slides were now placed at the advancing edge of the strand or weft, and upon these were placed small sections of cotton roots, which had been previously boiled and then steamed for several hours for three or four successive days, to thoroughly sterilize them. Sections of such roots about 3^{cm} long were placed, with the aid

[2]**Through the kindness of Prof. Geo. W. Curtis, Dir. of the Agri. Exp. Sta., Mr. R. D. Blackshear, Navasota, and Mr. W. H. Farley, Hutto, Texas.**

of forceps reddened in the flame, upon the sterilized glass slide, so that one end came in contact with the weft or strand of the *Ozonium*.

At the same time similar sections of sterilized cotton roots were placed in test tubes and partly imbedded in moist sand or partly immersed in distilled water, the tubes with their contents afterwards being thoroughly steam sterilized.

In from twenty-four to forty-eight hours the *Ozonium* strands would bite hold of the bait placed before them and secure such firm hold that the section of root could be transferred bodily to the prepared culture tubes, placing the end containing the growth in contact with the sterilized root already in the tube. Sterilized sweet potatoes were also used in test tubes as a medium upon which to place the transplantings.

Since the fungus grew rather slowly, and there was always danger that it might be contaminated by other fungus threads which had crept along with it, or with bacteria, some thirty or forty moist chambers during a period of six weeks were used, and more than 200 baits were set for the fungus. Out of this number seventy-five baits, which were promising, were transferred to roots in the culture tubes, and from these four or five finally proved to be pure. From these, baits could now be easily handled, so that in the course of two weeks I had multiplied the cultures to the number of fifty.

Great difficulty was encountered in baiting in such a way as to avoid contamination from strands and wefts of *Œdocephalum*, several species of *Fusarium*, *Penicillium*, *Mucor* and some non-fruiting forms, which also grew out from the roots and crept over the filter paper. In several cases bacteria were starved out by making the medium slightly acid with the use of lactic acid.

The *Ozonium* on artificial media, as sterilized cotton roots or sweet potatoes, grows readily after once obtaining a firm hold, and possesses all the characteristics observable in a natural condition upon cotton roots. Being free from obstructions and hindrances which it encounters in nature, the growth is perhaps much more compact, numerous strands uniting to form a broad weft, but the peculiar strands are present, as well as the characteristic branching setæ.

In the first transplantings the fungus grew with difficulty, since I did not have the conditions perfect, but as with expe-

rience I became more and more familiar with its habits, I found it an easy matter to cultivate it with certainty and in profusion.

Botanical Department, Cornell University.

A vacation in the Hawaiian Islands.

DOUGLAS HOUGHTON CAMPBELL.

(Concluded from p. 416.)

Of the trees of this lower forest region, much the most conspicuous is the Aleurites Moluccana, a euphorbiaceous tree, called by the natives kukui, with pale silvery green foliage which makes it noticeable at a long distance. The large oily seeds are used as food; and, formerly at least, the expressed oil was used for various purposes. A little higher up, the koa (Acacia koa), one of the commonest forest trees, abounds. This has phyllodia, like so many of the Australian acacias, and it is the principal timber tree, the wood being not unlike mahogany in appearance. Another conspicuous tree of the higher forest region is the ohia, or mountain apple (Eugenia Malaccensis), one of the Myrtaceæ, a medium-sized tree with beautiful crimson fruits not unlike a bell-flower apple in shape. The pulp is white and watery, pleasant to the taste, and very refreshing. Higher still, the related Metrosideros is very abundant, and with its grey-green leaves and scarlet feathery flowers is a striking object.

Owing to the almost constant rains, most of the valleys are traversed by permanent streams, and the floors of these valleys are very productive. Here are found the principal taro plantations. The taro plant (Colocasia antiquorum), familiar enough in American gardens under the name of Caladium esculentum, is the food staple of the great majority of native Hawaiians. Its large farinaceous tuber, after being deprived of its acrid properties by heat, is either directly baked or boiled for eating, or, more commonly, the baked taro is ground up with water into a sort of porridge, allowed to ferment, and served in the form of "poi". This is a sticky, unpleasant-looking mess, which, nevertheless, appears to be very nutritious.

Beside visiting the isle of Oahu, I made short trips to the islands of Hawaii and Kauai. The former, the largest of the group, and the only one where volcanic action is still going on, is reached by steamer in about thirty-six hours from Honolulu. On the way, the islands of Molokai, Lanai, and Maui are passed. The first, a barren looking and forbidding spot, is the location of the leper settlement, to which all persons afflicted with leprosy are sent as soon as their condition becomes known.

Maui, the largest of the islands next to Hawaii, consists of two portions connected by a narrow isthmus. The whole eastern half is nothing more nor less than the body of an immense extinct volcano, ten thousand feet high, and with a crater nearly ten miles across. The other end of the island is an older formation. This island is said to be very interesting botanically; but, unfortunately, my time did not permit me to visit it.

Very soon after sighting Maui, the three great mountain masses of Hawaii began to loom up. The day was clear, and the whole formation of the island became visible. It consists of three great volcanic cones, of which only one is now active. The highest summit, Mauna Kea, is nearly 14,000 feet above the level of the sea; the next, Mauna Loa, lacks but a few hundred feet of this; yet so great is the breadth of these masses that one fails to realize their immense height. Our first landing was at Mahukona, on the leeward side of the island, a most forlorn expanse of bare lava with scarcely a trace of vegetation, except a few unhappy looking algaroba trees planted about the straggling buildings that constituted the hamlet.

We lay all day at this inhospitable station, not getting away until evening. A beautiful sunset and a fine glimpse of the peak of Mauna Kea glowing with the last rays of the sun, form my most pleasant recollections of this desolate place.

What a change the next morning! On awakening we found ourselves entering the harbor of Hilo. Here everything is as green as can be imagined, and luxuriant vegetation comes down to the very ocean's edge. The town is built on a bay fringed with cocoanut trees and embowered in a wealth of tropical vegetation. Owing to the great annual rainfall (about 180 inches), as well as to the fact that Hawaii is the most southerly of the islands, the vegetation here is the most

luxuriant and tropical found in the whole group. I remained in Hilo for six days and collected some most interesting specimens. Through the kindness of Mr. Hitchcock of Hilo, I was enabled to spend the night at his camp in the woods near the town, and the greater part of two days collecting in the vicinity. The forest here is most interesting. Mr. Hitchcock was starting a coffee plantation and had cut trails through the woods in several directions so that collecting was very convenient. There is great danger of losing one's self in these woods where there are no trails, as much of the forest is an almost impassable jungle. In these moist forests ferns and mosses luxuriate, and every trunk and log is closely draped with those beautiful growths. Flowers are almost entirely wanting, a fact repeatedly observed by collectors in tropical forests. I saw here fully developed specimens of tree-ferns. The finest of these were species of Cibotium. Many had trunks from fifteen to twenty feet high, and some must have been fully thirty. The most beautiful were some with trunks ten to fifteen feet high, as these were more symmetrical and had finer fronds than the taller ones. I measured the leaves of one that had fallen over, and roughly estimated the length as eighteen feet. I have no doubt that specimens fully twenty feet long could be found. These giant fronds, arching high over one's head as one rides on horseback under them, present a sight at once unique and beautiful. Growing upon the trunks of these ferns were many epiphytic species, the most peculiar of which was Ophioglossum pendulum, with long strap-shaped leaves, a foot or two long, and a spike of sporangia sometimes six inches long. Exquisite species of Hymenophyllum and Trichomanes, the most ethereal of all the fern-tribes, with almost transparent, filmy leaves, were common, sometimes completely enveloping the trunks of the trees. Of the terrestrial ferns, which abounded everywhere, two were especially notable as representing groups unknown in the United States. One of these, Gleichenia dichotoma, forms extensive thickets on the borders of the forest, and in the Hilo district extends down almost to the sea-level. The other, Marattia Douglasii, a very large fern with leaves eight to ten feet long in well grown specimens, has fleshy dark green leaves, and thick stipules sheathing the base of the leaf-stalks. Several species of Lycopodium and Selaginella were common, and a good

variety of mosses and liverworts. In these forests wild bananas are common, and most magnificent plants they are. Sheltered from the wind, the superb great leaves develop to their full size, without being torn in the least, and the whole plant is a study of beautiful form and color.

Coffee is being extensively planted in this region as well as upon the lee side of the island, and as the quality of the berry is exceptionally fine, this promises soon to be a leading industry in the Islands.

About Hilo especially, but common also elsewhere, was a very conspicuous black fungus, that covered the leaves completely in many cases, and attacked indiscriminately a great variety of trees.

From Hilo I proceeded to the volcano of Kilauea, some thirty miles distant, and about 4,000 feet above the level of the sea. As this volcano has so often been the theme of travellers' descriptions I will not linger over it. In the vicinity are many interesting plants, among them a species of Vaccinium with sub-acid yellow and red berries something like cranberries. These "ohelo" berries are much esteemed, and are especially good when cooked. Some two miles from the volcano is a superb grove of koa trees, the largest trees I saw anywhere in the Islands. One of these standing alone, and with magnificent spread of branches, must have been ten feet in diameter. The road to the volcano lies for much of the way through a fine forest. In the lower part the ohia trees were loaded with their beautiful crimson fruit and present a very showy appearance. Of flowers, the species of Ipomœa were the most conspicuous; but the scarlet flower-bracts of Freycinetia were conspicuous at times, for here this latter plant may often be seen running to the tops of the tallest trees.

The glory of this road, however, is the tree-ferns, which all along excite one's admiration. The carriage road is not yet completed, and about thirteen miles must be done on horseback. Of this more than a mile is over a corduroy road made out of the trunks of ferns! Such a road, if not very durable, is yet very pleasant to horses. As these trunks lay prostrate, in the damp atmosphere, most of them were already sending out new fronds, and in due course of time, the road will be fringed with a hedge of great fern-leaves. Indeed, in some of the more open parts of the road farther

down, where the ground is completely occupied by a small tree-fern growing in dense thickets, as these are grubbed out to make way for cultivation, their trunks are piled up to form fences, and soon sprout out so that they make a beautiful and close hedge of fern-leaves.

On leaving the volcano, I went down on the other side of the island. The rain being almost entirely intercepted by the mountains, this leeward side is very dry, and the ride to Punaluu, where we were to take the steamer was not especially pleasant. Vegetation is very scanty, and nothing particularly interesting was noted in this line. The soil on this side of the island, especially in the district of Kona, is very fertile, and when water can be had, produces magnificent crops of all the tropical staples, pine-apples, cocoa-nuts, coffee, sugar, etc., all especially fine; and we feasted on these cocoa-nuts and pine-apples as we sailed along this picturesque, if somewhat barren, coast.

A short, flying trip was made to the Island of Kauai, the richest botanically of all the islands, as it is the oldest geologically. According to Hillebrand, not only is the number of species larger than in the other islands, but the species are more specialized. Here I saw several species of the curious woody Lobeliaceæ, of which there are several genera that form either shrubs or small trees. I saw several species of Cyanea, with stems six to eight feet high, with long leaves crowded at the top of the stem and many white or purplish flowers, much like those of Lobelia, but somewhat larger and less open.

As in all the islands, there is on Kauai a great difference between the windward and leeward sides. I drove for about thirty miles along the windward side of this island through some of the most beautiful scenery of all the islands. Near the sea, were rolling plains and hills, with here and there groves of Pandanus and Hau — the latter a dense spreading small tree with large yellow hibiscus-flowers — and at one point we drove through a magnificent grove of kukui trees, the finest I saw anywhere. As we reached that part of the island which is most fully exposed to the moisture-laden trade-winds, vegetation became extremely luxuriant. Numerous valleys with clear streams flowing down them, their bottoms given up to rice plantations, were to be seen here, with the rice in all stages from the young spears just stand-

ing above the water to golden-yellow patches of ripe grain. At Hanalei, my destination, I found excellent accommodation and a delightful bathing beach, the latter especially attractive after a thirty-five-mile drive over dusty roads. Hanalei is beautifully situated on a picturesque bay with bold mountains rising directly back. The next morning a native was hired to go with me into the woods, and the day was spent in collecting. The variety of trees, as well as other phaenogams, is much greater here than in Hawaii; the ferns, also, were very fine. Here I obtained a prize in a fine lot of the prothallia and young plants of Marattia, as well as some other interesting things.

Want of space forbids going into details; but no botanist visiting the islands can afford to miss Kauai.

In position, the Hawaiian Islands are unique, being more isolated than any other land of equal area upon the globe. More than 2,000 miles separates them from the mainland, and 1,860 miles from the nearest high islands. Of purely volcanic origin, thrown up from an immense depth, they have always been thus isolated. As might be expected, the flora is very peculiar, more so than in any other country. According to Hillebrand, of 800 species of spermaphytes and pteridophytes that are strictly indigenous, 653 or seventy-five per cent. are endemic. Taking out the pteridophytes, the spermaphytes show over eighty-one per cent; and the dicotyledons over eighty-five per cent. that are found only in this group.

For a thorough study of this very curious flora, a long time would be necessary, as many species are extraordinarily local, and many of the most interesting localities are very difficult of access. The islands differ extremely among themselves, and exhibit in a most interesting manner the correspondence that exists between the variety and differentiation of forms and the ages of the islands. The formation of the islands has proceeded from north to south; and Kauai, the northernmost of the large islands of the group is also the oldest and much the richest botanically, especially as regards spermaphytes; and, according to Hillebrand, the genera and species are more differentiated. Hawaii, the southernmost of the islands, is much the poorest in forms, although in the Hilo district the conditions are most favorable for a luxuriant development of forms.

In the latter island is the last active volcano of the group, Mauna Loa with its two creaters, of which the well-known crater of Kilauea is the great sight of the islands and visited constantly by tourists from all parts of the world.

A few days after my return to Honolulu from Kauai, and six weeks from my first arrival there, I boarded the Monowai, the through Australian steamer bound for San Francisco, which was reached in due season after an uneventful passage. And so ended my first trip to the tropics.

Leland Stanford Junior University.

Botanical papers presented at the New Orleans meeting of the American Association of Agricultural Colleges and Experiment Stations.

L. H. PAMMEL.

The botanists in attendance at the New Orleans meeting were not numerous, and the same may be said of the horticulturists. On invitation of the botanists, the horticulturists met with them. The association later united the sections of botany and horticulture.

Papers enough were presented to take at least a forenoon and an afternoon, but owing to the meetings of the general sessions it was impossible to get all of the members together at any one time. The meetings at different times could only be an hour long. The meeting on Thursday morning was devoted to the important topic of the station and laboratory exhibit at the World's Columbian exposition, which was discussed by Dr. True and Prof. Tracy.

It would seem that more time should be given to a discussion of methods of investigation and more time allotted to the different sections. Botanical investigations appear to the writer to be an important part of station work.

The following papers were presented:

BYRON D. HALSTED: *Quince diseases.*—The following fungous troubles of the quince fruit were treated, namely: The quince rust (*Rœstelia aurantiaca* Pk.); the fruit spot (*Entomosporium maculatum* Lév.); the black rot of the quince (*Sphæropsis malorum* Pk.); the quince pale rot (*Phoma*

Cydoniæ Sacc.)?; the ripe rot of the quince (*Glœosporium fructigenum* Berk.), and the quince blotch, due to a fungus the life history of which is not yet worked out and whose affinities are obscure.

The black rot is the same as that of the apple and the fact that this was unusually destructive seems due to there being a large apple tree among the quince trees with the ground beneath it covered with fruit decaying with the sphæropsis. The pale rot may prove to be a new species, as *Phoma Cydoniae* Sacc. has a very incomplete description and is recorded only for leaves. By inoculations it was shown that the ripe rot is the same as that of the apple and grape, namely, *Glœosporium fructigenum* Berk. These various decays were photographed.

BYRON D. HALSTED: *New Jersey Peronosporeæ.*—After recording the substance of the field notes made upon the various species, stress was laid upon the fact that during the autumn months, which were unusually dry, there was more than the ordinary amount of the members of the genus Cystopus. While the peronosporas prefer a wet season, the white moulds seem to thrive best when the weather is dry. In a further study of the methods that these mildews have for passing the winter, it was found that some species grow upon the fruits of the host and doubtless, as in *Ipomœa hederacea*, the filaments penetrate the seeds, and when the latter germinate the parasite develops with the host. Large numbers of small young seedlings badly affected in the cotyledons, and roots even, were taken.

The importance of making field notes upon the prevalence of particular fungous parasites extending over many seasons was urged in the paper.

BYRON D. HALSTED: *Weed seeds.*—Samples of a collection of weed seeds then being made by the writer were exhibited, for an account of which, see this journal, XVII, 427.

GEORGE F. ATKINSON: *On a method of obtaining a pure culture of Pammel's fungus of Texas root rot of cotton.*—Printed in full in this issue.

GEORGE F. ATKINSON: *A new "damping off" fungus.*—"Damping off" has usually been attributed to *Pythium De Baryanum*, but Atkinson found in young cotton affected with what is commonly called "sore shin" among planters, *Rhizopus nigricans*, *Fusarium*, and a non-fruiting form of a fungus

having threads from 9μ to 11μ in diameter and 100μ to 200μ in length, colorless at first, finally becoming brown. The fungus was isolated and grown in acid nutrient agar. Plants grown in sterilized soil when inoculated with this fungus dropped over and had this characteristic fungus. The same fungus was obtained from the inoculated plants. The author concludes that probably much of the damage attributed to *Pythium* is caused by this fungus.

L. R. JONES: *The antagonistic relations of certain potato diseases.*—Three diseases have been observed in Vermont, (1) blight and rot, *(Phytophthora infestans)*; (2) the macrosporium disease; (3) a bacterial disease. The phytophthora disease, and the macrosporium disease, or a disease associated with Macrosporium has been very common in Vermont in 1890, 1891 and 1892. He has watched these diseases and noted that there is an annual struggle between them. "It is comparatively rare that a tuber affected by the characteristic dry rot of Phytophthora is found among the tubers where the vine is destroyed by the new disease." The author concludes that if the climatic conditions remain as they have during the past three years in Vermont and only early potatoes are planted, the new disease would tend to exterminate the *Phytopthora.*

L. H. PAMMEL: *Preliminary notes on a rutabaga and turnip rot.*—The disease is not associated with any of the higher fungi, but there are present in the tissues numerous bacteria. Cultures of several species have been obtained, and one of these apparently produces a rotting similar to those found in the field. The inoculated plants were in the field so the demonstration is by no means conclusive. More work is under way. A curious feature in connection with the disease is that the dry weather in September not only checked the disease completely, but such plants as had rotted almost entirely recovered by forming a corky layer around the diseased portions.

L. H. PAMMEL: *Some experiments in the prevention of Cercospora Ribis and Cylindrosporium Padi.*—The author detailed some experiments in treating these diseases with ammoniacal carbonate of copper, Bordeaux mixture, and sulphosteatite. Bordeaux mixture proved most effective, the plants having retained their foliage well into October. In 1891 ammoniacal carbonate of copper gave good results, but

the season was more favorable. In seasons like 1892 with an abundance of rain the sulphosteatite and ammoniacal carbonate of copper wash off much easier then the Bordeaux mixture.

L. H. PAMMEL: *Relation of frost to certain plants.*—This paper gave a record of the exact temperature at which certain plants were killed. In several cases like castor-oil bean the lower leaves were affected while the upper long remained green. So also *Zea Mays*, *Scabiosa atropurpurea*, *Marrubium vulgare*, *Nepeta cataria*, *Phlox Drummondii* and *Cosmos* are quite resistant to frost.

S. A. BEACH: *Bean anthracnose and its treatment.*—It has been known for some time that when anthracnosed seed is planted the disease most frequently is found on the cotyledons as soon as they push through the surface of the soil, but it may be found on any other part of the plant above the roots. Experiments made in treating the seed and plants as compared with clean seed show that the selection of clean seed is the most important and effective method of securing healthy plants.

Iowa Agricultural College, Ames.

BRIEFER ARTICLES.

The use of blue-print paper in recording root curvatures.—The common blue print paper so much used by photographers, architects, and mechanical engineers, is not, so far as we are aware, of frequent use in botanical laboratories; yet it may be employed for a number of purposes with a considerable saving of time. We have found it particularly valuable in printing the angles of both primary and secondary roots that have been subjected to galvanic currents, and also in printing the geotropic bendings of secondary roots, to make an accurate drawing of which would require considerable time; whereas an exact reproduction can be obtained in a very few minutes. This is most easily accomplished if we have either an air or water culture, by fastening a piece of the sensitive paper to the outside of the glass jar in which the plants are growing, and exposing them for a few moments to sunlight. It is better still, especially if the plants are cultivated in cylindrical jars, to transfer them to a rectangular glass jar filled with water, and of sufficient size as to allow the secondary roots to main-

tain their natural position. Such a jar as is commonly used for the cultivation of seedlings answers well for this purpose. The sensitive paper can be fastened to the back of the jar by means of soft wax. The object should be exposed to strong sunlight, and a window should be chosen in which the direct rays can be reflected horizontally from a mirror upon the object, which in turn projects its shadow upon the sensitive paper. The object should be placed as near the paper as possible so that a well-marked shadow is obtained, and consequently a clearly defined print. From two to five minutes exposure in strong sunlight is sufficient to obtain a print, after which the paper should be treated to a water bath and dried in the usual way.— GEORGE E. STONE, *Leipzig.*

A new order of Schizomycetes.— The following should be substituted for lines twenty-two to thirty in the preceding number of this journal, p. 403.

Myxobacter aureus n. sp.— Plate XXV, figs. 34–36.— Colonies when rising to form cysts milky white. Rods large, cylindrical, rounded at either end, $4-7 \times .7-.9\mu$. Cysts spherical or oblong, golden yellow, thick walled, one to twelve or more in number, distinct within a hyaline matrix, $75-350 \times 75-275\mu$. The encysted rods mingled with a yellow oily material. Cyst groups $.7-1^{mm}$ long.

On very wet wood and bark, in swamps. Kittery Point, Me., Belmont, Mass.

Myxobacter simplex n. sp.— Rods as in *M. aureus.* Cysts solitary within a thin envelope, very large, irregularly rounded, bright reddish yellow, $250-400\mu$ in diameter. The encysted rods flesh-colored in the mass and adhering in numerous elongate groups.

Occurring, sometimes with the last, in the same localities and habitat.

The two species above described are very common in the situations mentioned, being found most frequently on sticks lying in partly dry wood pools. In general appearance they greatly resemble a minute Trichia, and are conspicuous from their very bright color. The cysts or groups of cysts are never crowded, and are usually sparsely scattered over the substratum. Neither of these forms has been cultivated apart from its natural substratum. In *M. aureus* all stages of development have been obtained from the first appearance of the rising rod mass. The cysts are formed from this mass by a rolling together of the rods at certain points corresponding in number to the cysts to be produced. As the cysts roll themselves together, they become gradually separated from the hyaline matrix in which they are finally imbedded. The

cyst wall in both species is thick and clearly defined, the contents becoming contracted and clearly separated from it on the addition of glycerine or salt solution. The two species seem to be quite distinct, the reddish color and peculiar grouping of the cyst contents of *M. simplex* as well as its solitary habit being apparently constant characters.—ROLAND THAXTER, *Cambridge, Mass.*

EDITORIAL.

THE TIME is ripe for the establishment of a School of Botany in connection with some one of our large universities. In most of them, this great biological science is represented by a single man with or without assistance, and most of these men are considered fortunate that they are not compelled to teach zoology also. But in this respect there has recently been rapid improvement, and botany to-day stands fairly well differentiated. But we are now advocating further advance. The field of botany has become so vast that one man cannot stand for it all, and of necessity does injustice to the science and to his pupils. If a teacher is worth anything he is cultivating some one phase of the subject, and is impressing his pupils with the importance of that phase. The consequence is that our smaller colleges are being filled with botanists who know only one kind of botany, which is perfectly right and proper, and think every other kind of little or no consequence, which is by no means right and proper. These teachers lack a true perspective of their subject, and propagate the little dogmas of their training schools as persistently as do the religious sects their creeds.

IT IS THIS BROAD VIEW that was lost when botanists were compelled to specialize; and this view is to be restored by the establishment of schools of botany, in which, as in the Pantheon, all views are represented. It must not be supposed for a moment that we are advocating a diffusion of botanical training for the individual; but a student being trained in one department of botany can be made to appreciate the proper importance of other departments that are being cultivated about him. In addition to this a certain amount of elementary training in all the great departments is necessary, and this can be best directed by those who stand for these departments. It is urged that any good botanist can give a sufficient elementary training in the whole subject. We consider this to be a fallacy. It may be true for a a year or two after the teacher has passed from under the guidance of

distinguished specialists, but how can he be expected to keep step with the rapid advance in every department? It is our opinion that more antiquated anatomy and physiology, to say nothing of taxonomy (which of course includes the facts of morphology), are being taught in this country by well known botanists than we would care to acknowledge. Anatomists (still called histologists in some quarters) are apt to give little or no conception of modern physiology, and none whatever of our fluctuating taxonomy. Taxonomists (both in specific and genetic lines) are likely to be fair anatomists, but simply retailers of an obsolete physiology. As for physiologists, we may be said, as yet, to have none. We have some fair "readers" of the subject, and others who are mechanically expert enough to devise pieces of apparatus, but as a distinct department in this country, physiology is yet to be established.

A SCHOOL OF BOTANY would prevent this lop-sided presentation of the subject, and would develop a race of botanists with broader views. Such a center of investigation and instruction will doubtless soon be established, as educational matters are moving just now with remarkable rapidity.

CURRENT LITERATURE.

Handbook of British Fungi.

Few systematic works, especially of those relating to cryptogams, have enjoyed such a long period of uninterrupted usefulness as Cooke's "Handbook of British Fungi," published in 1871, in two volumes. Although long since out of print, the demand for it has not abated, as the high price in the second-hand catalogues fully shows. Its popularity was not due to its ever having been a satisfactory work, but to the fact that it was the only work covering the ground. The number of species included in it was 2,810, while the number now recorded for the same territory is about 4,900. There have also been great advances in the classification of the fungi in the last two decades.

In view of these facts the announcement of a new handbook like the old one, but "with all the modern improvements," gives much satisfaction. The new work is to be in three volumes, the first one being already before us. It is prepared by Mr. George Massee,[1] and in size and general appearance resembles Cooke's work.

[1] MASSEE, GEORGE. — British fungus-flora: a classified text-book of mycology. 3 vols. 8vo. Vol. I. pp. xii: 422. Illustrated.

This first volume is devoted to the Basidiomycetes, beginning with the Gasteromycetes. The descriptions are accompanied with few critical notes, and no indication of geographical distribution, or relative abundance, which will somewhat curtail its usefulness to American students. The few illustrations are crudely drawn and wretchedly printed. The typography and general make up of the volume are, however, excellent.

There is much difference of opinion regarding the limitations of species and genera, especially in the Hymenomycetes, and the present work shows a number of deviations which will not be satisfactory to many. The matter can better be discussed elsewhere, however; it will suffice to note that the genus Agaricus is cut down until it includes only twelve species, while in Cooke's Handbook it embraced 452 species, and in Stevenson's recent Handbook of British fungi it embraces 782 species.

A botanical dictionary.

For a long time there has been much need for a revised dictionary of botanical terms. The recent rapid growth of the science and its extension into new fields has introduced many technical terms not found in former works of the kind, of which the last one issued was by Paxton and Lindley, dated 1868. The work by A. A. Crozier,[1] from the press of Henry Holt & Co., is therefore a timely publication. It defines over five thousand words, very few of which are obsolete terms. The vowel sounds and accent of the words are indicated, but the derivation is not given. Not only exclusively technical terms are given a place, which are for the most part also found in the Century dictionary, but also other words, which have beside their usual meaning a special botanical application, e. g., accessory, aggregation, entire, drooping.

It is not surprising to find that the work does not include all the terms which the reader of recent botanical writings may desire to have defined. Sometimes the word is included, but without mention of the particular specific application of it, e. g., hadrome, leptome, stereome, bulliform, as descriptive of certain peculiar structures in grass leaves. Sometimes the word is omitted entirely, e. g., aërotropism, carene, chemotactic, thermotonus. The number of omitted words, especially of those belonging to vegetable physiology, appears to be considerable, but possibly not larger than any compilation would be likely to show upon its first issue. If the book meets with the suc-

[1]CROZIER, A. A.—A dictionary of botanical terms. 8vo. pp. 292. Henry Holt & Co., New York, 1892. $2.50.

cess it deserves, it will not be long before a second edition will be required, which should also be an augmented one.

It is particularly gratifying to note that for the first time in any dictionary the much abused words "fungoid" and "fungous" are correctly defined and their proper usage indicated.

The book is admirably printed and bound, and makes a convenient reference volume.

Minor Notices.

WEST VIRGINIA has been incompletely explored, and containing a knot of mountains that is neither northern nor southern, botanists have long regarded it as very desirable territory. Even a hasty survey has yielded rich results, as Dr. Millspaugh's Preliminary Catalogue[1], now before us, will testify. It will be impossible for us to note all the interesting features of the flora. The nomenclature used is practically in accord with the Rochester rules, and several combinations appear for the first time. The catalogue includes not only all the observed existing flora, from *Clematis* to *Epicoccum*, but a supplement presents to us the rich fossil flora of the State. Quite a number of new species are described, the two plates illustrating a new moss and a new liverwort. The list contains, exclusive of the fossil flora, 1,189 species of phanerogams, 39 pteridophytes, 107 bryophytes, and 164 thallophytes, 1,499 in all; to which number may be added numerous varieties and forms. Dr. Millspaugh has been unfortunate in his state printer, a thing with which others who print without proper control of the proof can sympathize.

THE CONIFERS have long occupied the attention of the distinguished editor of the *Gardeners' Chronicle*, Dr. Maxwell T. Masters. There are now before us two reprints[2] containing some of the results of his labors. The Chiswick address is a very interesting presentation of this important group of plants, and its completeness may be judged from the following captions: antiquity, genealogy, stages of growth, physiology, movements, etc., practical illustrations, beauty of form and color, stature, utility, nomenclature, introduction of species into cultivation, economic value.

[1] MILLSPAUGH, CHARLES F.—Flora of West Virginia. Bulletin No. 24 of W. Va. Agricultural Experiment Station, Morgantown, W. Va. 1892, pp. 314–538, with two plates.

[2] MASTERS, MAXWELL T.—(1) Some features of interest in the order of Conifers, being an Introductory address at the Chiswick Conifer Conference (Oct. 1891). [Reprinted from Jour. Roy. Hort. Soc. XIV, pp. 20.] (2) List of Conifers and Taxads in cultivation in the open air in Great Britain and Ireland. [Reprint, l. c., pp. 80.]

The more important "list" is introduced by an account of the literature of the group, following which the genera and species are presented alphabetically. The literature, synonymy, and native habitat are fully cited, and as most of our North American species are cultivated in the British Isles the list becomes quite a complete bibliographical index of the group for American botanists. In regard to nomenclature the author has followed the principles of Bentham and Hooker, so that the names adopted are not to be considered as representing the most recent agreement concerning nomenclature.

DIONÆA has always been a fascinating study, and although its history seemed to be fully written, Mr. Bashford Dean[1] has given us a most interesting account of its actions in its native haunts, and has supplied us with valuable information. It has always been a question whether we were getting at all the facts from the study of greenhouse specimens. Mr. Dean summarizes some of his results as follows: (1) Specialization for the capture of ground insects. (2) Marked differences in irritability in individual leaves; the usual inability of the plant to capture and retain larger and more active insects; the usual failure of the plant to capture transient insects; the repeated closings of the trap upon inorganic and vegetable objects. (3) The sensitiveness of the trap in parts other than the filaments. It would seem that the name "fly-trap" is singularly inappropriate.

THE FLORA of Lower California promises to be as prolific of new things as that of Mexico. Mr. Brandegee has already published a voluminous report of this region, and has now issued[2] a small pamphlet containing "additions," which were the result of a trip to the Cape region in March and April of 1892. In addition to interesting plants already described, we note four new species, three of which are *Leguminosæ* (Dalea, Acacia, and Albizzia). The occurrence of an Albizzia in our N. American flora is unexpected, as the genus was thought to be confined to warm regions of the orient.

THE FLORA OF MEXICO, owing to the persistent activity of that wonderful collector, Mr. C. G. Pringle, is being rapidly brought to our knowledge. It is also a very great advantage that so much of this rich flora is to be represented by such fine material as types. Dr. B. L. Robinson, the new Curator of the Harvard Herbarium, has been working at

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[1]DEAN, BASHFORD.—Dionæa. Its life habits under native conditions. From observations made near Wilmington, N. C. (April 1891.) [Reprinted from Trans. N. Y. Acad. Sci., 12. pp. 9.]

[2]BRANDEGEE, T. S.—Additions to the Flora of the Cape Region of Baja California. [Extract from Proc. Cal. Acad. Sci., II. III. 218–227.]

the Pringle collections of 1890 and 1891, and has just published[1] some of his results. Nearly forty new species are described, the majority of which are *Compositæ*. Two new genera are proposed: *Coulterophytum*, a genus of umbellifers belonging to *Selineæ*; and *Geissolepis*, a genus of composites belonging to *Galinosogeæ*. We regret the omission of the index, which always made Dr. Watson's contributions so easy to use, and a thing which Dr. Gray never would provide.

OPEN LETTERS.

The meeting at Madison in 1893.

No one need fear that there is not enthusiasm among the botanists of America. There is an unlimited supply of botanical enthusiasm in the air. The whole atmosphere is electric with it and the only problem is how to collect a little of this universal enthusiasm for the meeting at Madison. The meeting is the Leyden jar that must be charged from the general botanical atmosphere of the country. I have one practical suggestion to make and that is this: Let a plan be outlined for a complete exhibit at the Madison meeting of photographic views of the different botanical laboratories of the country. Let the gathering together of this exhibit be placed in the hands of some committee that will be willing to give some careful thought to the administrative detail of the whole matter and let it be advertised thoroughly so that the exhibit will be a complete one and a creditable one. To the "distinguished foreign guests" promised us by the GAZETTE such an exhibit would be peculiarly grateful and it would be a delicate attention on our part to present before this extracontinental contingent our material aspect together with our intellectually inspiring papers.

It is not only to the foreign botanist that such an exhibit would be valuable but particularly also to those misguided fellow-citizens in science who are unable to get beyond the notions of their childhood about botanical methods and still believe that the botanist is a man who analyses flowers and busies himself principally with the beauties and incidentally with the sterner realities of Nature. My old friends the "biologists," whom I have often had occasion to reprove more in sorrow than in anger, will be benefited, I know, by such an exhibit and it might in some degree compensate them for the absence in the future from their sectional meetings of the refining, broadening and inspiring influence of the botanists.

And even the leaders of the zoological wing might be afforded some information that would be of value to them by such an exhibit. I

[1] ROBINSON, B. L.—Descriptions of new plants collected in Mexico by C. G. Pringle, in 1890 and 1891, with notes upon a few other species. [Reprinted rom Proc. Am. Acad. 27. pp. 165–185.].

have in mind the unfortunate wording of the *Programme of Courses in Biology* at the University of Chicago which has recently come under my eye. In it I discover a classification of the biological sciences that is, as I have characterized it, unfortunate, for it comes under the supervision of a very able zoologist and consequently from a region whence we might have looked for better things. Under the head of "organization of the school" six departments are mentioned. These are: 1, zoology; 2, anatomy; 3, neurology; 4, palaeontology; 5, physiology; 6, botany. From such a classification it is plain that the position of botany in a *true* classification is not apprehended. The erroneous use of the word botany in such a connection is no less remarkable than the erroneous use of the word zoology as exclusive of anatomy, for example. But this will hardly palliate the offence against accurate use of terms in the setting off of botany as coördinate with palaeontology or neurology, and such parallelism is clearly indicated in the grouping used in the circular before me. It is a matter of regret to us all that in an institution of so much promise as the new Chicago University there should be so evidently retrogressive a movement. While over the world and here at home in our Association there is seen going on the segregation of the different branches of biological science and the accurate limiting of their fields, this classification of the Chicago programme is a movement backward to the old natural-history group (though under another name); and even in this group there is what a humble botanical worker with no pretensions to the name of biologist must be permitted to say is contrary to what he has been taught is an exact use of words, and certainly opposed to what he has been led to believe by study and reading and observation to be a correct classification of science-groups..

If a display of the material side would have any effect upon the minds of these wanderers from the philological fold, I suggest that the botanists present it, for their science, at Madison in 1893.—CONWAY MACMILLAN, *University of Minnesota.*

An International Botanical Congress.

Since the meeting of the botanists at Rochester last August it has become evident that an international botanical congress should be held in 1893 in this country. Upon the return of Professor Underwood from Genoa, with his report of what was done there, as well as of what was left undone, such a congress seemed a necessity, especially when it was learned that the delegates to the Genoa congress expected one to be held in America this year in order to complete the work left by them. The Columbian Exposition will doubtless bring many botanists to this country during the year. Most of these will attend our scientific meetings if possible, and it seems wise to take advantage of this and to arrange for a formal congress. There being no committee to take charge of the work of preparing for the congress, after consultation with a number of botanists, it was thought advisable that the chairman of the Section of Botany of the American Association for the Advancement of Science, and the president of the Botanical Club, Dr. Wilson, should appoint a committee to take the matter in hand. Accordingly on Dec. 9th, notices were sent to the following gentlemen

with the request that they serve on such committee: J. C. Arthur, L. H. Bailey, N. L. Britton, D. H. Campbell, J. M. Coulter, B. T. Galloway, Conway MacMillan, B. L. Robinson, William Trelease, L. M. Underwood, George Vasey.

May I not ask a hearty support be given to the committee by every botanist, to the end that the congress may be every way successful.—CHARLES E. BESSEY, *Chairman Section G* (*Botany*), *A. A. A. S.*

Lesquereux's Flora of the Dakota Group: A reply.

In the October number of the GAZETTE I find a review of Lesquereux's *Flora of the Dakota Group*, which I seem to have been so unfortunate in editing. As this review is so evidently the vehicle of a personal attack, you will, I trust, grant me space for a few words of editorial explanation. My reviewer says: "The best method of editing a posthumous work is, undoubtedly, to carry it out in the same spirit in which it was written, taking all facts into consideration." Had he taken the trouble to read the editor's preface he would have seen that this was precisely what has been done. The only changes made in the MS. as submitted by Lesquereux, except such slight verbal ones as were necessary to make the meaning more clear, *are mentioned in foot-notes* (twenty-three in number) *signed with the editor's initials, and the whole, if gathered together, would not fill one printed page!* The book is Lesquereux's own, and the criticism therefore becomes one of the author, not of the editor.

But let us examine some of the so-called editorial blunders. There are, we are informed, "incorrect citations." As only high ecclesiastics lay claim to infallibility, it is not perhaps remarkable that out of nearly a thousand bibliographic references, including page, plate and figure, a few errors should creep in, but it would have been more satisfactory had some of them, or at least one, been pointed out! "The plates . . . . are poorly arranged." The plates are divided into three series, the first embracing forty-five plates, the second nineteen plates, and the third three plates, and the figures are arranged upon them (of course in three series) as nearly in systematic order as the size and character of the drawings will permit. This arrangement was fixed by the author before the editor assumed charge, for as stated in the editor's preface, the book was completed once, and sent to Washington, but before it could be taken up for publication a great amount of new material was discovered in Kansas, and Lesquereux asked that the manuscript and plates be returned to him. This new material added 110 new species and twenty-one plates. Lesquereux left figures for nineteen of these plates, and the remaining three were made under the supervision of the editor. The author made hundreds of references and cross-references to the plates as thus arranged. To have changed this arrangement would not only have involved many errors, but was actually impossible, for the tint of the India ink work was not the same on the last series of plates as on the first, and hence they could not have been reproduced by the mechanical processes required at the government printing office, had the two kinds been mixed on the same plate.

"The spelling of names is inconsistent." It is indeed a *gross* typo-

graphical error that we should have both *grossi-* and *grosse-dentatum!* "Often the specific name is in the wrong gender." *Fagus orbiculatum* is wrong in the text, but is correct in the plate, and would have been changed, as were the fifteen subspecies of *Betulites* (p. 61), had it been noticed in time. The species of *Sassafras* pointed out as being in the wrong gender, were first printed by Saporta and Heer in this form, and have been adopted in most European works for upwards of twenty-five years. It was not assumed to be the function of an editor of a posthumous work to make corrections of this character, notwithstanding the fact that the reviewer says: ". . . there are many things that are admissible in a manuscript, written as the thought first comes to us, and pleasing for a time to the fancy, which should be omitted in print!" (It is a matter of great regret that no general rule for the application of this principle was laid down for the guidance of future editors.)

"Misleading phrases; *e. g.*: 'dots like the impression of basilar points of hairs.'" Basilar parts of hairs would have perhaps been better, but the phrase is not misleading as it stands, for when a leaf covered with a firm pubescence becomes fossilized, the impression bears the imprint of the bases of the hairs on which they appear like dots, as stated by Lesquereux. Again, the expression "A bunch of small pediceled seeds like a *Carex*" is general and popular rather than misleading, for every one knows that technically the fruit of *Carex* is an achene (the fruit of *Citrus Aurantium* is a superior polycarpellary syncarpous plurilocular berry, yet some people still call them oranges!), which is often called, and for all popular and practical purposes *is* a seed. The resemblance of the fossil under discussion to a bunch of the fruits of *Carex* is clear enough.

"Furthermore, there is a too indiscriminate use of terms, *e. g.*, basal basilar and basil." The first two words are of course synonymous and correctly employed, while the other (basil) is another one of those unfortunate typographical errors which the reviewer has so kindly pointed out! It should be *basal*. The quotation under *Protophyllum denticulatum* is garbled and misleading as quoted, but is self-explaining when presented in full. Following is the complete text (p. 193) the italicised words representing the parts taken: "Leaf coriaceous, round or reniform, enlarged on the sides, truncate at the base, minutely but sharply denticulate all around except at the base, petioled; *median nerve* thick, percurrent; *lateral primaries supra-basilar*, very open, the upper branched outside, the lower simple, thin, at right angles to the midrib; *secondaries* four pairs, subopposite, more or less branching, craspedodrome *with their divisions; nervilles* at right angles to the secondaries, distinct, simple or forked."

"On page ninety-two we learn that 'the nerves are attached to each other.'" There is no such expression on this page or anything that can be distorted into it. The statement that there is but one species of *Diospyros* in North America is of course not quite true, for there is another relatively unimportant species (*D. Texana*) in southern Texas. The claim that there are illustrations not named is not supported by facts, and that "there are others not numbered" is true in only one case, plate XXI fig. 1, which is instantly restored, by people of ordinary intelligence, by exclusion.

Thus the array of *so-called* editorial blunders seem to resolve themselves into a few simple typographical errors, which every one who has anything to do with printing, must know how difficult it is to keep out of a work of this magnitude (400 pages, sixty-six plates), and while the general public may be able to "readily observe the wide gap between the genial and elegant work of Lesquereux and the lack of care and taste in the present edition," the editor earnestly begs them to look in the book for themselves, and throws himself upon their mercy.— F. H. KNOWLTON, *Washington, D. C.*

NEWS AND NOTES.

AT ITS LAST anniversary meeting the Royal Society awarded the Darwin Medal to Sir Joseph Hooker.

DR. G. VON LAGERHEIM has resigned his position in Quito, Ecuador, and gone to Tromsö, Norway, which is his present address.

AS WE GO to press word has been received of the death of Mr. I. C. Martindale, of Camden, N. J. His botanical specimens are known in many collections, and his own herbarium is one of the largest private collections in this country, and was always in most exemplary order.

MR. FRANCIS DARWIN, son of the great naturalist, and the joint author of *The Power of Movement in Plants*, at present Reader in Botany at Cambridge, has, on the nomination of Professor Babington, been appointed Deputy Professor for the current academical year.— *Gard. Chron.*

"THE COLLECTION of cycadeous plants in cultivation at Kew stands unrivalled, both in regard to the number of species represented, and the size of the specimens generally." This sentence introduces a very interesting account of the Kew Cycads, to be found in *Gardeners' Chronicle* (Oct. 22).

A NEW MONTHLY JOURNAL of botany is promised to make its appearance this month. It will be under the direction of members of the Botanical Department of the University of California, and under the editorial charge of Mr. Willis L. Jepson. Its name is to be *Erythea*, and its price $1.50.

THE SIMULTANEOUS publication in the GAZETTE and the *American Naturalist* of Dr. G. W. Martin's paper on the development of the flowers and embryo-sac in Aster and Solidago was entirely unexpected by the editors of either journal. The author sent a copy to each without notice of the duplication, and by accident the article appeared in the same issues of both magazines.

M. CASIMIR DE CANDOLLE has repeated (more elaborately) Sachs' experiments upon the flowering of plants under the influence of the ultra-violet rays. It will be remembered that Sachs considered these rays indispensable to the formation of flowers. DeCandolle finds them to be favorable rather than indispensable, and the question still remains unanswered how the rays act.

Probably the largest specimen of *Acanthorhiza aculeata* Wendl. (a curious species of Central American palms) in cultivation in Europe has just bloomed for the first time at Kew. The generic name refers to the curious spinous roots, which in the species mentioned clothe the stem to a height of a foot above the ground.

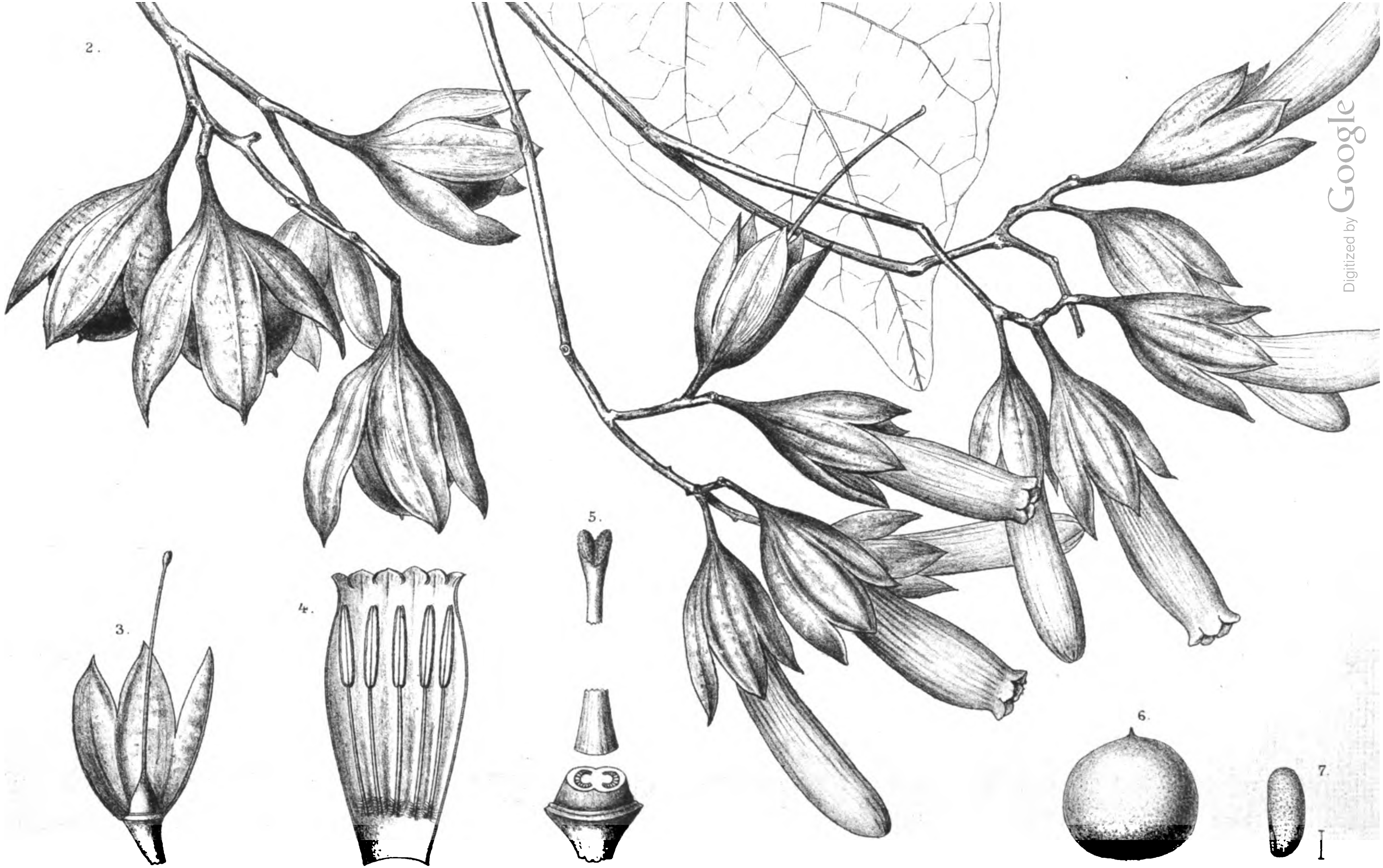
The State University of Iowa has sent Professor B. Shimek to Nicaragua, to follow the route of the canal as near as practicable and make a general investigation of the country; its general character (fertility, climate, etc.), its people, its geology, its flora (special attention being paid to the cryptogamic flora), and its fauna. It is expected that he will return to Iowa City with his collections not later than April 1, 1893.

Mr. Geo. M. Thomson, of New Zealand, has an interesting paper in *Science* (Dec. 9) entited "Biological Notes from New Zealand." We are delighted to see that under this caption our friend of the antipodes deals only with certain peculiarities of New Zealand plants! He notes particularly the rarity of those plant structures which are correlated with the presence of mammalia, such as spines for protection and hold-fasts for distribution.

Mr. W. N. Suksdorf, of White Salmon, has issued a catalogue of the phanerogams and pteridophytes of Washington. He has long been collector of that interesting flora, and his specimens are to be found in all our larger herbaria. As nearly all of his plants have been determined by eminent botanists, the recent catalogue can be relied upon. The list contains 1,642 phanerogams and 48 pteridophytes, and can be had of the author for 25 cents.

Several state academies of science met during the holiday week. The program of the Nebraska society contains twenty-two papers, of which eight are upon botanical subjects. In Ohio there are thirty-seven papers upon the program, of which sixteen are botanical, in Iowa twenty-five papers of which eight are botanical, and in Indiana the program embraces ninety papers, of which twenty-five are botanical. These local societies appear to be flourishing, and are accomplishing a good work.

The National Council of Education (a department of the N. E. A.), is considering the general subject of uniformity in school programs and in requirements for admission to college. President Eliot is the chairman of the standing committee of ten. This committee has appointed conference committees to discuss and report upon the different subjects. The conference committee on "Natural History" met at Chicago University, December 28th, and among its ten members are found the following botanists: Chas. E. Bessey, Douglas H. Campbell, and John M. Coulter.



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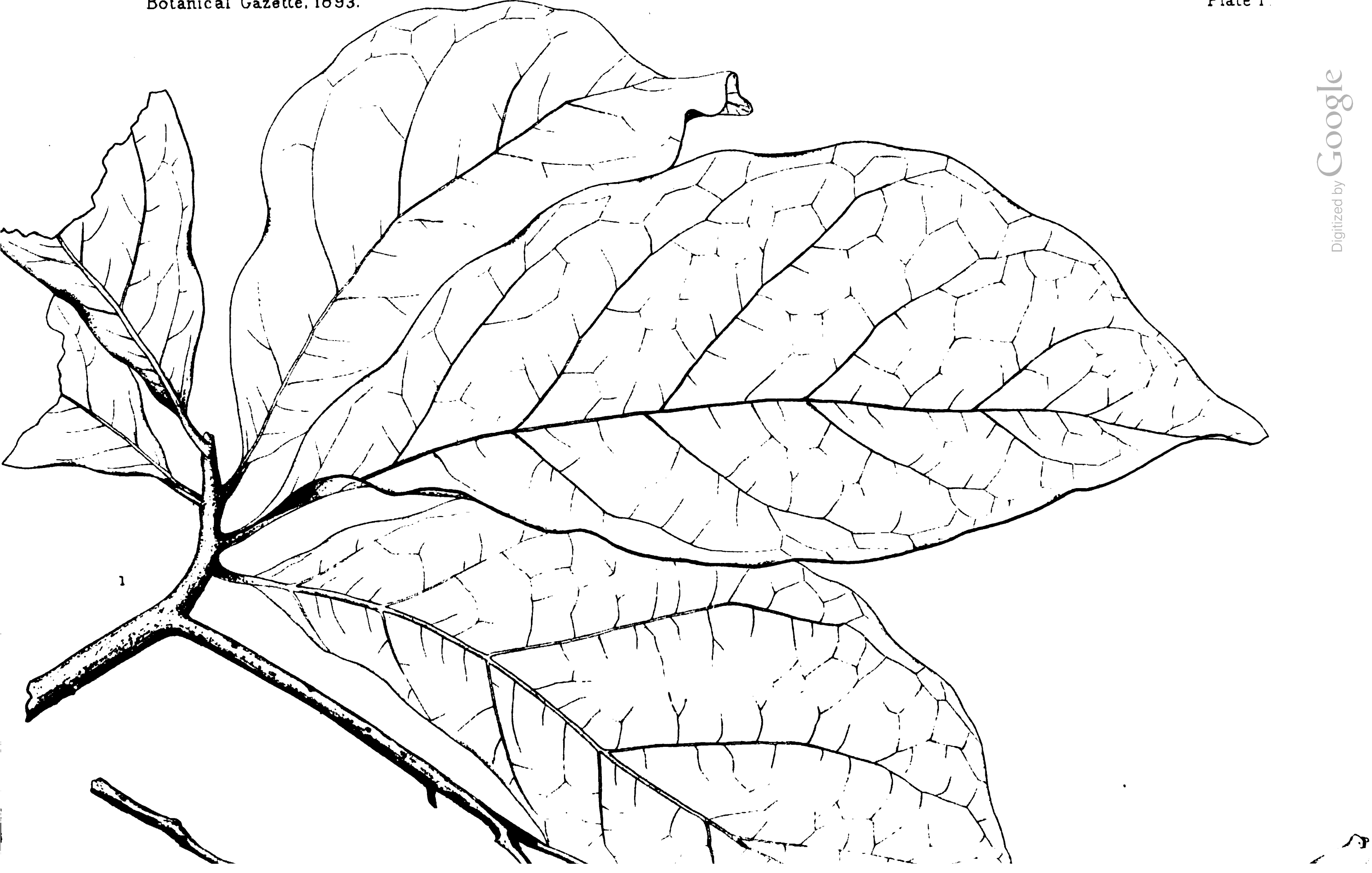
JUANULLOA SARGII, n. sp.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BOTANICAL GAZETTE

FEBRUARY, 1893.

A comparative study of the roots of Ranunculaceæ.

FRED. B. MAXWELL.

WITH PLATES II—IV.

(Continued from p. 16.)

II. Methods of investigation.

I began collecting material for this work in August, 1891, and continued collecting until the ground became frozen in the fall. The roots of Ranunculaceæ being generally fibrous, and often very long and slender, it was no easy matter to obtain material that would answer my purpose, as in all cases I desired perfect root tips for the study of the meristem, besides pieces of the root from several points in its length for the comparative study of the general structure. Of many of the species I obtained plants which were potted and after getting them started in a cold frame they were placed in the green house, and when more material was needed I had but to take the plant from the pot, disturbing it as little as possible, and then repot it to keep for farther use. My best sections were obtained in this way, for after the plants became thoroughly established the root tips were abundant and there was not the danger of injuring them in collecting which necessarily attends out-door collection of such material. Another advantage from this method was that they were always ready at hand when more material was needed to corroborate some point. The material was all dehydrated and hardened in alcohol, a Thomas dehydrating apparatus being used. It was then prepared according to the collodion method, in all cases serial longitudinal sections of the root tip being made for the study of the meristem. Over three hundred slides were prepared, about two hundred of which furnished the material for my study. The roots of some of the plants were so small that the making of good sections was a difficult task. Among such roots are those of *Anemone Caroliniana*, *Coptis*

trifolia, and *Anemonella thalictroides*. Many of these roots which were sectioned were less than .5^{mm} in diameter. Sectioning such roots met with many failures, especially in getting good longisections of the tip. One series of transections of a root the diameter of which could not have been over .25^{mm} was obtained, which showed the bundle structure fairly well. Careful camera lucida drawings were made of the transections of most of the roots, and these with the sections of the roots themselves were studied in making my comparisons. All of these drawings could not be embodied in this thesis, but many of them will be found on the plates. In the study of the meristem structure rough drawings were made of most of the tips, then comparisons were made, and but one detailed drawing was made for each type of structure.

III. General structure.

As to the general histological structure, especially as to the difference between old and young roots, I should make two general classes of the plants of Ranunculaceæ, first, those not showing decided secondary change in older roots, and second, those presenting certain modifications from the primary structure in the older roots; in the second class there are two different modifications of the primary structure, thus making three classes.

The first class includes those plants in which the original radial structure persists in the older roots, that is secondary growth produces but little change in the plan of root structure. The cortex may become less compact by the disappearance of cells, and the xylem may increase in the number of its rays, and its vessels in the number and thickness of their walls, but the primary radial structure is still evident. As especially good representatives of this class I would name the roots of *Ranunculus septentrionalis* and *Ranunculus acris*. In these the smallest branches and the largest main roots showed exactly the same type of structure. This plan for *R. acris* is shown in plate II, figs. 5 and 6. In both of these plants the oldest roots showed in the bundle area simply an increase in the number of the xylem vessels, and in the cortex irregular air spaces occurred through the disappearance of cells in certain areas or the tearing apart of the cells through rapid growth, but the plan of structure was still the same as in the younger roots, this being a triad or tetrad radial bundle. In

this class I would also include *Hepatica acutiloba*,[1] *H. triloba*, *Aconitum Noveboracense*,[2] *Trollius laxus*, *Caltha palustris*,[3] *Ranunculus recurvatus*, *R. Pennsylvanicus*, *R. fascicularis*,[5] *R. circinatus*,[6] *R. aquatilis* var. *trichophyllus*,[7] *R. bulbosus*, *R. multifidus*,[8] *R. septentrionalis*, and *R. hispidus* Michx.,[9] a form not recognized as a distinct species in Gray's Manual, but it is certainly a very distinct type and I believe is recognized as a species by many botanists, though others regard it as a variety of *R. fascicularis* or *R. septentrionalis*. In root structure it is more like the latter. In all of these species which I could get to study, the roots, both young and old, large and small, had the characteristic radial type of root structure. In certain cases it might be that at another time of the year the roots would have presented a different structure, though as most of my material was collected in the fall the larger roots collected then ought to have shown it, if there was to be a change through secondary growth.

The second class on this basis would include those plants in which, by the growth of secondary xylem rays between the primary ones and in front of the phloem masses (these secondary rays often becoming more prominent than the primary ones), the radial character of the young root is lost and the bundle appears like a collateral one with the xylem collected in the center and the phloem in separated groups answering to the original number of the xylem rays, and lying entirely without the xylem mass. Along with the change in the bundle area the endodermis generally undergoes a change. Through division the cells become much smaller and often nearly square in form; and the whole central cylinder becomes larger in proportion to the diameter of the root, partly through increase in bundle elements and partly through increase of conjunctive parenchyma. On the other hand many of the roots of the first class show a smaller central cylinder in the older roots, the increase principally having taken place in the cortex.

As a good example of this second class of roots, I will des-

[1] Plate III, figs. 13, 14.
[2] Plate IV, figs 22, 23.
[3] Plate III, figs. 17, 18.
[5] Plate II, figs. 9, 10.
[6] Plate II, figs. 3, 4.
[7] Plate II, figs. 1, 2.
[8] Plate II, figs. 11, 12.
[9] Plate II, figs. 7, 8.

cribe the two forms of structure as found in the young and old roots of *Clematis Virginiana.*[10] In the young root (fig. 25) the are as marked *x* are the primary xylem rays and *ph* the phloem masses, the cells of which are not drawn, the endodermis is seen at *en*, the cortex at *c*, and the epidermis at *e*.

The structure of the older roots is represented in fig. 24 in which the original xylem rays are at *x*, and secondary xylem rays, *x'*, have been developed so as to be more prominent than the original rays, and have pushed the phloem, *ph*, toward the endodermis; at *a* is what appears to be meristematic tissue, peripherad of which are the phloem cells. All within the dotted line is of thick walled cells, probably a part of the secondary xylem. The endodermis has become somewhat modified though not as much so as in many of the roots of this class, but the central cylinder is notably larger in proportion than in the smaller roots, as the figures well show.

About the same change in structure between the old and young roots is shown in plate IV, figs. 26 and 27, which were drawn from sections of the roots of *Cimicifuga racemosa.* Here the primary xylem and phloem have a tetrad arrangement, but practically the same secondary change has taken place in the older roots and as the lettering is the same the figures will need no explanation. In this class also belong *Anemone Virginiana*[11] and its var. *alba*, *A. Pennsylvanica*, *Actæa alba*,[12] *A. spicata* var. *rubra*, *Clematis verticillaris*, *Coptis trifolia*, *Hydrastis Canadensis*, and *Ranunculus sceleratus*. The structure of the younger roots of *Anemone Virginiana* and its var. *alba*, and of both species of *Actæa* are found represented in the figures. In all, the secondary changes are very similar to those already described, and need no detailed description. The only singular thing about this class is that we find *Ranunculus sceleratus* here, for it is the only *Ranunculus* that shows marked secondary change. As it is reckoned by Dr. Gray as an annual, we should hardly expect a change to occur here, while the roots of *Ranunculus acris*, which is certainly a perennial, do not show secondary change.

I should make a third class of structure for *Thalictrum dioicum*, *Thalictrum polygamum*, *Anemonella thalictroides*, and *Aquilegia Canadensis*, for the larger roots of these plants

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[10] Plate IV, figs. 24, 25.
[11] Plate III, figs. 15, 16.
[12] Plate III, figs. 19, 21.

present a very peculiar structure, as compared with the structure of the roots of the other plants of the order. I will endeavor to make this clear by describing the structure of the older roots of *Thalictrum dioicum.*[13] The smaller, younger roots of all of these plants show the usual radial root structure, and do not deserve particular description. This plant, and especially *Thalictrum polygamum*, has a numerous cluster of large fibrous roots, and it is the structure of these roots that will be described. A cross section of these roots shows a very large central cylinder enclosed by a very regular endodermis composed of very small square cells. The xylem vessels are in a rather compact cluster at the center, and radiating from this are from two to four rays of phloem, each ray of two or more separated groups, the cells of which are very small and thin walled. Sometimes the central xylem presents the same number of short rays as the phloem The greater mass of the central cylinder is occupied by very regular and generally angular cells, the walls of which are often slightly thickened. The cortex is very small in proportion to the central cylinder and is of roundish loosely packed cells. At first an epidermis is present, but most of these roots gathered in the fall had exfoliated their epidermis together with all but about two rows of very loosely packed cortex cells. This leaves the endodermis as the real protecting organ, and perhaps accounts for its rather peculiar appearance. The walls of the endodermal cells are generally cutinized.

The structure of a younger root of *T. polygamum* is shown in plate III, fig. 20 and plate IV, fig. 28. The style of structure which has been described for the older roots of *T. dioicum* was also observed in the older roots of *T. polygamum* and *Aquilegia Canadensis*, and in the tuber-like roots of *Anemonella thalictroides*, though with minor differences in each case. I have not examined the roots of *Isopyrum biternatum*, but from Prof. Hargitt's description I should say it too belonged in this class.

From the above descriptions it will be seen that Olivier's statements concerning the genus *Ranunculus* are borne out by my observations, for in only one species, *Ranunculus sceleratus*, could I discover any great change of structure through secondary development. The exfoliation of the cortex of the Thalictrums is spoken of by both Olivier and Ma-

[13]Plate IV, fig. 29.

rie, though I had made out these facts for myself before knowing what their statements were. Marie also refers to the two forms of structure as found in roots like those of *Actæa alba.*

IV. Miscellaneous considerations.

Treub, among others, proposed to use anatomical characters to aid in the classification of plants, using root characters as well as those of the stem and leaf. Erickson in discussing this idea said that he did not think this could be accomplished, for his study showed him that very nearly related plants showed very different histological structures, and that in many roots which he studied he could not tell the one from the other. From my study of the roots of the *Ranunculaceæ* I should say that anatomical characters, especially root characters, could only be used in a very general way, for I think these vary more according to environment than according to specific relations, and much change of structure is seen in the roots of the same species, especially between younger and older conditions of it. With a few orders and genera, and perhaps species, it is possible that some anatomical character might be found which would be an aid in classification, but I am certain that among the *Ranunculaceæ* I could not tell the difference between the roots of many of the genera; and as to species I should be entirely at a loss to characterize them by root structure. I emphasize the fact that environment influences structure more than specific relations. For example, all the plants of *Ranunculaceæ* inhabiting wet places, no matter of what species, presented in transection rounded cortex cells, and these loosely packed, the spaces between the cells being numerous and varying in size and number in almost direct proportion to the aquatic or terrestrial habit of the plant. On the other hand, plants of very dry ground generally showed angular cortex cells and almost invariably few and small spaces between them. Another difference noted was that the roots of water *Ranunculaceæ* present a poor development of the vascular system, its office probably being filled by the more abundant spaces between the cells, especially in certain roots in which many of the spaces are continuous cavities surrounded by cells. These differences are well illustrated in plate II, figs. 1 and 3, and plate III, fig. 19, Figs. 1 and 3 represent the roots of *Ranunculus circinatus* and *R. aquatilis* var. *trichophyllus.* Both of these grow in water,

and we find that the cortex cells are round and have many spaces between the cells, while fig. 19 represents the roots of *Actæa alba*, which grows on dry banks, and here the cortex cells are angular and the spaces between cells are almost none. The differences in vascular development are also well shown in these figures.

In this part of the paper I have not discussed the general structure of the species studied as regards the occurrence and distribution of the histological elements, since I find that Marie, Hegelmaier, and others have described the general structure of many species of *Ranunculaceæ*, and in many cases my descriptions would have been but a repetition of theirs.

University of Chicago.

Flowers and insects. X.

CHARLES ROBERTSON.

STEIRONEMA LANCEOLATUM Gray.—The plants are commonly collected in small patches. They grow 3 or 4^{dm} high, and expose a few yellow flowers with reddish-purple centers. The flowers look outwards and a little downwards, and expand from 20 to 25^{mm}. In the bud each corolla lobe enfolds an anther. When the flower expands, the lobes carry the enclosed anthers with them, holding them while the stigma is receptive and is exposed to insects—a fact to which my attention was first called by Professor Pammel. After the anthers are released, the styles are commonly found bent outwards, out of the way of the falling pollen. Sprengel supposed that flowers of *Lysimachia quadrifolia* were nectar bearing, but failed to find nectar. He, and Müller also, failed to find honey in flowers of *L. vulgaris*. According to Kirchner nectar is wanting in *L. nemorum* as well as in *L. nummularia*. I have been uncertain in regard to the occurrence of honey in Steironema, but the visits of male bees seem to indicate its presence, although these insects might search for it in vain. They commonly fly about the flowers to find the females, not trying to find honey.

I have noted the flowers in bloom from June 20th to July 12th. As far as I have observed, they are visited for honey and pollen only by *Macropis steironematis* Rob. ♂♀.

STEIRONEMA LONGIFOLIUM Gray.—This plant resembles the preceding, but grows somewhat taller and bears a greater profusion of flowers. The flowers are without purplish centers. They appear more homogamous, the anthers being more readily released by the lobes, and the style not being bent aside. The flowers were noted in bloom from July 26th to August 23d. The only visitors observed were *Macropis steironematis* Rob. ♂♀, c. p., and perhaps s., abundant, and *Halictus confusus* Sm. ♀, c. p., once.

The flowers of Lysimachia and Steironema seem to hold, as regards their economy, an important mutual relation with bees of the genus *Macropis*. In the "Fertilization of Flowers" Müller states that he found the females of *Macropis labiata*, as a rule, only on flowers of *Lysimachia vulgaris*, and the only other cases cited in that work of the occurrence of *Macropis* on flowers are the visits of the males to flowers of *Œnanthe fistulosa*, *Rhamnus Frangula*, *Melilotus alba* and *Rubus fruticosus*. The other insects observed by Müller on *L. vulgaris* were rare and their visits evidently have no significance. In the Entomologist's Monthly Magazine, XVII, 31–35, Mr. W. H. Patton states that in Connecticut he found *Macropis ciliata* ♀ on flowers of *Steironema ciliatum*, *Rhus glabra*, *R. typhina* and *Archangelica hirsuta*, but says nothing about them collecting pollen. The male was captured on flowers of *Rubus villosus* and *Cornus paniculata*. *M. patellata* ♂ was taken on flowers of either *Cicuta* or *Rhus* and on *Steironema ciliatum*. I have taken *M. steironematis* on flowers of *Ceanothus Americanus*, *Apocynum cannabinum* and *Melilotus alba*, but I have never seen the female collecting any pollen except that of Steironema. We have here a case which as far as mutual dependence goes bears a strong resemblance to the case of Yucca and Pronuba.

FRASERA CAROLINENSIS Walt.—The plants are frequent on rich hillsides, blooming, as far as observed, from May 26th to June 12th. The stem grows as high as two meters, and bears an immense panicle of pale-greenish flowers, which measure about 35^{mm} across.

The flowers are pendulous. The four lanceolate petals expand horizontally. They have whitish bases and greenish tips. On the middle of each petal, about 3^{mm} from its base, is situated a peculiar nectariferous depression, which is oval in outline, about 4^{mm} long by 3^{mm} wide and 1^{mm} deep. This is sur-

rounded by a dense circle of hairs, which form a crest over the cavity and completely conceal the nectar. Some of the hairs are bent downwards, and their tips are turned into the cavity. Besides concealing the nectar from small short-tongued intruders which could not effect pollination, the hairs serve as foot-holds for insects to cling to when extracting the sweets. About this nectary the petals are purple-dotted—the dots serving as path-finders.

Four divergent stamens about 13^{mm} long alternate with the petals, while the stigma occupies the center of the circle. Self-pollination is prevented by the strong proterandry.

When an insect clings to one of the crested nectaries, its body is fairly certain to touch the anthers on that side, as well as the stigma. The size of the flower, however, indicates that the insect, in order to do this, must be of large size. I expected to see the flowers visited by bumble-bees, which, after all, may prove to be the principal visitors, but after watching them on June 10th and 11th the only insect observed sucking, which could effect pollination, was *Polistes metricus* Say ♀. It clings to the stamens and style with its posterior legs and can readily strike the anthers and stigma. *Halictus coriaceus* Sm. ♀ visits the flower for honey and pollen, but is too small to do any good.

ELLISIA NYCTELEA L.—The plant is common, rises about 2^{dm}, is scattered in thin patches, and is commonly rendered quite inconspicuous by the surrounding vegetation. The rather diffuse branches bear only a few flowers, which bloom in succession, so that, in their visits, insects are as likely to pass between flowers of distinct plants as from flower to flower on the same plant. The flowers vary in position from erect to pendulous, the calyx lobes, which equal the corolla in length, often concealing it from view.

The corolla measures about 4 or 5^{mm} in length and expands about 6^{mm}. The tube is about 4^{mm} long and is as wide as 2^{mm}, so that it readily admits the head and thorax of small bees. The border is turned out nearly horizontally and is divided into five rounded lobes. With the exception of three to five purplish dots on the middle of the lobes, the color is white. A few hairs on the inner wall of the corolla tube seem to have little significance.

Five stamens alternate with the corolla lobes and bend to the center of the flower, so that to reach the nectar, insects

are required to insert their tongues between the filaments. Each filament has on each side of its base a fimbriate appendage which tends to close the interval. Then the ovary is densely clothed with erect bristle-like hairs which also aid in concealing the nectar. The disk surrounding the base of the ovary shows five nectar secreting processes alternating with the filaments.

The flower is homogamous. The style with its receptive stigma rises among the dehiscent anthers, being generally overtopped by them, so that self-pollination may readily occur with or without insect aid.

Probably on account of strong competition with its allies and other plants the flower seems to have gone through a stage in which it was neglected by insects and was compelled to rely upon self-pollination. At present I find it abundantly visited, to an extent that would seem to justify the return of dichogamic characters.

But the damp shady situations in which the plant grows, no doubt, render the visits of insects quite uncertain, so that the power of spontaneous self-pollination becomes a most important condition of selection. The flower is adapted to small bees, especially *Halictus.* It blooms from April 21st to June 21st. May 8th, 12th and 21st the following visitors were observed:

Hymenoptera—*Apidae:* (1) Ceratina tejonensis Cr. ♂, ab.; (2) C. dupla Say ♂♀, ab.; (3) Osmia albiventris Cr. ♂; (4) O. atriventris Cr. ♂♀; (5) Nomada maculata Cr. ♀; *Andrenidae* (6) Andrena violae Rob. ♀; (7) A. ziziae Rob. ♂; (8) Augochlora pura Say ♀, ab.; (9) Halictus 4-maculatus Rob. ♀, ab.; (10) H. pectoralis Sm. ♀; (11) H. fasciatus Nyl. ♀, ab.; (12) H. obscurus Rob. ♀, ab.; (13) H. zephyrus Sm. ♀; (14) H. tegularis Rob. ♀; (15) H. stultus Cr. ♀—all s.

Diptera—*Bombylidae:* (16) Bombylius pulchellus Lw., s.; (17) B. fratellus Wd., s.; *Syrphidae:* (18) Pipiza femoralis Lw., f. p.; (19) Mesograpta marginata Say, f. p.; (20) M. geminata Say, f. p.; (21) Rhingia nasica Say, s.

COMANDRA UMBELLATA Nutt.—The flower is remarkable for being specially adapted to flies. The calyx is white and expands about 5^{mm}. It is generally 5-, sometimes 3- or 4-parted. The tube is 2 or 3^{mm} long, lined within by a green disk which above forms lobes alternating with the stamens and calyx lobes. This disk, especially at its exposed lobes, secretes

nectar which is very attractive to flesh-flies. Visitors have abundant pollen massed about the bases of their proboscides.

The flowers are homogamous. The stigma somewhat surpasses the anthers and is separated from them. I do not think spontaneous self-pollination occurs, unless it be in bad weather.

The plants are common, often in large patches, grow from 1 to 2^{dm} high and expose an umbel-like cluster of flowers. The flowers bloom from April 27th to June 6th. The following list of visitors was observed on May 12th, 16th, 17th, and 19th:

Diptera—*Syrphidae:* (1) Sphaerophoria cylindrica Say, ab.; (2) Volucella vesiculosa F.; (3) Eristalis dimidiatus Wd.; (4) Helophilus latifrons Lw.; (5) Tropidia mamillata Lw.; (6) Syritta pipiens L.; *Tachinidae:* (7) sp.; (8) Trichophora echinomoides Twns.; (9) Gonia frontosa Say; *Sarcophagidae:* (10) Cynomyia sp., very ab.; (11–13) Sarcophaga spp., very ab.; *Muscidae:* (14) Calliphora erythrocephala Mg., freq.; (15) C. vomitoria L.; (6) Lucilia sp., very ab.; (17) L. caesar L., ab.; (18) L. iatifrons Schin., freq.; (19) L. sericata Mg., two; (20) L. cornicina F.; (21) L. sylvarum Mg., very ab.; (22) Graphomyia sp.; (23) Myospila meditabunda F.; *Anthomyidae:* (24) Limnophora sp., ab.; (25) Chortophila sp.; (26) Coenosia sp.; *Sciomyzidae:* (27) Tetanocera sp.—all sucking.

Hymenoptera—*Apidae:* (28) Apis mellifica L. ☿; (29) Synhalonia speciosa Cr. ♂; (30) Osmia albiventris Cr. ♀; (31) Nomada superba Cr. ♂; *Andrenidae:* (32) Andrena sayi Rob. ♀; (33) A. flavo-clypeata Sm. ♀: (34) A. mariae Rob. ♀; (35) Halictus lerouxii Lep. ♀; (36) H. confusus Sm. ♀; (37) H. albipennis Rob. ♀; (38) H. tegularis Rob. ♀; (39) Sphecodes arvensis Pttn. ♀—all sucking, rare.

Coleoptera—*Coccinellidae:* (40) Megilla maculata DeG., one; *Lampyridae:* (41) Telephorus bilineatus Say, one—both sucking.

SPIRANTHES GRACILIS Bigelow.[1]—The flowers are white and measure 4 or 5^{mm} long. The parts of the perianth, with the exception of the divergent lower sepals, are disposed so as to limit access to the nectar. The upper sepal is connivent with the two upper petals, forming the upper wall of the tube. At their free ends these parts form a three-toothed upper lip. The lower wall is formed by the labellum, whose

[1]See Darwin: Fertilization of Orchids; Gray: Am. Journ. Sci., XXXIV.

tip forms a lower lip. This is too small to form a landing-place for insects, but makes the flower a little more conspicuous. A proboscis about 4^{mm} long can drain the nectar with ease.

In Gray's Manual the time of blooming is stated to be from July to October, while in Chapman's Flora of the Southern States it is said to be in April and May. In Illinois I have found the plant in bloom in September. At Orlando, Florida, I noted it in bloom from February 18th to March 16th, and at Inverness, Citrus county, from March 15th to 23d. In Illinois I have seen the flowers visited by *Bombus americanorum* F. ♂ and *Calliopsis andreniformis* Sm. ♀. At Orlando, Florida, I saw them visited by a bee which I failed to capture, but which I supposed was *Anthidium notatum* Latr., and by *Megachile brevis* Say ♂.

The last mentioned insect has two boat-shaped discs with attached pollinia fastened to the maxillary laminæ, and I think this is the particular part of a bee to which the flower is adapted to fasten its pollinia. At Torquay, Darwin saw *S. autumnalis* visited by two species of bumble-bees. In one specimen which he examined he states that the pollinia were attached to the superior (maxillary) laminæ. The maxillary laminæ are on the upper side when the proboscis is inserted into a flower, and are the parts which would be expected to touch the disk first. But the most important consideration is that when the bee's proboscis is folded up under the head, the maxillary laminæ fall into such a position that the pollinia retain their hold without danger of being disturbed.

ORCHIS SPECTABILIS L.[2]—In my neighborhood there are many places favorable for the protection of this Orchis, and it is of rather frequent occurrence. It is found on north hillsides in rather shady places. The scapes grow from 1 to 2^{dm} high and bear several flowers. The labellum with its spur is white. It is nearly pendant and measures from 10 to 15^{mm} long by 8 to 10^{mm} wide. The other parts of the parianth are united into a purplish helm which effectually shelters the column and the mouth of the spur. The spur is from 12 to 15^{mm} long, is somewhat enlarged near the tip, and the nectar rises 2 to 3^{mm}.

The flower is specially adapted to *Bombus* females. At the

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[2] See Guignard: 16th ann. rep. Ent. Soc., Ontario; Mignault: Bemerkungen über die Befruchtung der Pflanzen.

time when it blossoms (May) only the females of *Bombus* are flying. The disks are applied to the bee's clypeus, which in the female is bare. The clypeus of the male is so hairy that the disks could hardly be properly fastened to them. Long-tongued species of *Anthophora* and *Synhalonia* are flying while the flowers bloom and can reach the nectar, but I do not believe the flowers are adapted to them, because the males, which fly at the same time, have hairy faces, and they would be as apt to visit the flowers. When the pollinia are withdrawn by a bee they stand in a nearly horizontal position, since the bee's clypeus has its face directed nearly vertically, so that in moving downwards to a position in which they will strike the stigma they must be assisted by their own weight.

On May 13th I found a patch of five plants, which bore twenty flowers. With the exception of three flowers, the pollinia were removed from all, and most of the stigmas had received pollen. I saw the flowers visited by the females of *Bombus separatus* Cr. and *B. americanorum* F. The proboscis of the former can drain the short-spurred flowers and obtain some of the nectar which rises in the long spurs. *Bombus americanorum* can easily exhaust the longest spurs. A specimen of this bee which I captured at the flowers has a pair of pollinia on the clypeus.

HABENARIA LEUCOPHÆA Gray.—The plant is rare. It grows on prairies. The stem rises from 4 to 8^{dm} and bears a raceme of greenish white flowers. The flower measures about 20^{mm} long by 15^{mm} wide.

The upper sepal and two upper petals form a galea which shelters the anther. The labellum is three parted, each division being fimbriate. The disks are set one on each side of the entrance to the spur and are separated about 2^{mm}, so that when the hawk-moth throws its proboscis to one side or the other, it is apt to remove one of the pollinia, but is not likely to extract both of them. The spur is very slender and measures from 35 to 40^{mm} in length, indicating that the flower is adapted to Sphingidae. The nectar does not seem to be enclosed between the walls of the spur but appears to occupy the cavity. The height to which it rises can be seen from the outside. Sometimes it fills the spur for 10^{mm} above the tip.

I have found the plant in bloom from June 12th to July 12th. July 2nd I captured at the flowers a specimen of *Chaero-*

campa tersa L. with three disks on its proboscis, about 4^{mm} from the base. At Champaign, Ill., Mr. M. B. Waite showed me a specimen of *Philampelus achemon* Dru., which he had taken on the flowers. It had pollinia about 5^{mm} from the base of the proboscis.

Carlinville, Illinois.

Notes on North American Umbelliferæ. III.

JOHN M. COULTER and J. N. ROSE.

WITH PLATE V.

The two preceding papers of this series were published in this journal November, 1889, and October, 1890. The present paper is a report upon the Umbelliferæ of Mr. John Donnell Smith's third distribution of Guatemalan plants. Most of the species were sent by H. Th. Heyde and Ernst Lux, who have made extensive collections for Mr. Smith. We have previously reported upon Guatemalan Umbelliferæ in this journal for January and October, 1890.

HYDROCOTYLE MEXICANA Cham. & Schl.—Rio Negro, Dept. Quiché, at an altitude of $3,600^{ft}$, June, 1892, no. 3,350. Collected by Heyde & Lux.

HYDROCOTYLE PROLIFERA Kell.—Amatitlan, Dept. Amatitlan, at an altitude of $3,990^{ft}$, May, 1892, no. 2,668. Collected by John Donnell Smith. This seems to be the same species collected at this place by Mr. Smith in 1889, and referred to in BOT. GAZ. XV. 259. Also from Santa Rosa, Dept. Santa Rosa, at an altitude of 3,000 to $4,000^{ft}$, April, 1892, no. 3,349. Collected by Heyde & Lux. This plant is less proliferous, the umbel sometimes being simple as in *H. umbellata*.

SPANANTHE PANICULATA Jacq.—Santa Rosa, Dept. Santa Rosa, at an altitude of 3,000 to $4,000^{ft}$, June 1892, no. 3,351. Collected by Heyde & Lux.

ERYNGIUM CARLINÆ Delar.—San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to $12,000^{ft}$, April, 1892, no. 3,356. Collected by Heyde & Lux.

SANICULA MEXICANA DC.—San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to $12,000^{ft}$, April, 1892, no. 3,357. Collected by Heyde & Lux.

ARRACACIA DONNELLSMITHII C. & R.—Volcan de Agua, Dept. Zacatepequez, at an altitude of 10,000 ft. Collected near the type locality by W. C. Shannon, June, 1892.

Arracacia Luxeana, n. sp.—Probably a tall perennial, branching, glabrous: leaves ternate to triternate; petioles wholly inflated; leaflets ovate to lanceolate, 2.5 to 7.5^{cm} long, sharply serrate, glabrous: peduncles short (10 to 12^{cm} long) or wanting: umbel somewhat unequally 15 to 30-rayed, with involucre wanting or of a single leaflet; involucels four to eight, foliaceous, lanceolate, sharply serrate, often 2.5^{cm} long; rays 5 to 10^{cm} long; pedicels 8 to 14^{mm} long: fruit ovate, acute, 6 to 8^{mm} long, glabrous, flattened laterally, with slender conical stylopodium: carpel terete, with five prominent ribs; commissure narrow; oil tubes solitary in the intervals, two on the commissural side: seed with deeply sulcate face and furrowed under the intervals.—In the forest near San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to 12,000^{ft}, April, 1892, no. 3,354. Collected by Lux.

EULOPHUS PEUCEDANOIDES Benth. & Hook.—Santa Rosa, Dept. Santa Rosa, at an altitude of 3,000 to 4,000^{ft}, May, 1892, no. 3,353. Collected by Heyde & Lux.

ENANTIOPHYLLA, n. gen.—Calyx-teeth obsolete. Fruit oblanceolate, flattened dorsally, glabrous. Carpel strongly flattened dorsally: dorsal and intermediate ribs prominent, acute; lateral ribs winged. Stylopodium slender, conical; styles furrowed on ventral face, slightly thickened above but not capitate. Oil-tubes solitary in the intervals, two on the commissural face. Seed strongly flattened dorsally, with a broad, shallow excavate face and furrowed under the intervals.—Tall glabrous perennials, with opposite ternately-compound leaves, lanceolate acute leaflets, linear bracts and bractlets, and white (?) flowers.

This genus belongs to Bentham and Hooker's subtribe ANGELICEÆ. From *Angelica* and *Prionosciadium* it differs chiefly in its conical stylopodium and opposite leaves. In fact, in the latter character it differs from most genera of *Umbelliferæ*, and has suggested the generic name. The genus is peculiar in having the carpel developed at the base into a broad stipe or foot, much as in Dr. Robinson's new genus *Coulterophytum*, but not so marked. It has several other characters in common with the latter genus, but has a

more compressed fruit and carpel, prominent dorsal and intermediate ribs and winged lateral ones, etc., etc.

Enantiophylla Heydeana, n. sp. Plate V.—From 12 to 15^{dm} high and much branched: leaves large, 3-ternate or 2-ternate-pinnate, or the upper ones simply ternate or pinnate; leaflets lanceolate, acuminate, 5 to 7.5^{cm} long, glabrous above, paler and minutely scabrous on the veins, sharply and finely serrate; petiole broad and inflated: inflorescence large; upper branches verticillate, terminated by an umbel; peduncle 3 to 7.5^{cm} long; rays 12 to 30^{mm} long; pedicels 6 to 8^{mm} long: bracts of involucre and involucel several, linear, and with scarious margins: fruit 10^{mm} long; wings of lateral ribs about as broad as body; the dorsal ribs sharp and equal.—Collected by Rosalió Gómez, in fruit, at Santiago, Depart. Zacatepequez, at an altitude of $6,500^{ft}$, 1891; and by Heyde, in flower, along the banks of the Rio Esclavo (where it is said to be common) near Santa Rosa, Depart. Santa Rosa, at an altitude of $3,000^{ft}$, May, 1892. Distributed by John Donnell Smith under nos. 788 and 3,352 respectively.

CORIANDRUM SATIVUM L.—Introduced. Santa Rosa, Dept. Santa Rosa, at an altitude of $3,000^{ft}$, July, 1892, no. 3,347. Collected by Heyde and Lux.

DAUCUS MONTANUS Willd.—San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to $12,000^{ft}$, April, 1892, no. 3,355. Collected by Heyde & Lux.

Bloomington, Ind., and Washington, D. C.

Influence of anæsthetics on plant transpiration.[1]

ALBERT SCHNEIDER.

WITH PLATE VI.

I. Historical and critical.

Recently Jumelle conducted some very interesting experiments on the influence of anæsthetics on plant transpiration. He made an extensive study of plant chemism, chlorophyll-function and transpiration, which led him to give his final report on plant anæsthesia in the July number, 1891, of the

[1]The researches described in this paper were carried on in the laboratories of physiological botany of the University of Minnesota at Minneapolis.

Revue Générale de Botanique. A very brief summary of his conclusions may be stated as follows:

1. The luminous rays of the sun are partially utilized in assisting assimilation and partially in increasing "chlorophyllian transpiration."

2. Part of the luminous rays are absorbed by the chlorophyll bodies and converted into heat, increasing vapor tension and thus aiding transpiration.

3. The same dose of sulphuric ether acts differently on plant transpiration in the light and the dark. In light transpiration is increased but in the dark retarded.

4. Augmentation in light of transpiration of the anæsthetized plant is due to the influence of the sulphuric ether on the chlorophyll bodies

5. The cause of retardation in the dark is not definitely explained.

6. Ether retards assimilation but increases chlorophyllian transpiration (in the light).

7. Ether partially arrests assimilation and the luminous rays no longer used in the assimilating function aid the chlorophyllian transpiration.

8. The same results are reached when assimilation is retarded by any means.

As will be seen from these conclusions, Jumelle adheres to the chemical theory of chlorophyllian transpiration as do also Wiesner and others. Pringsheim, Kohl, and others maintain that the influence of chlorophyll is purely mechanical, acting as a sort of a shade to protect the plastid from certain rays of sunlight. It is a well known fact that plants transpire, though devoid of chlorophyll, as in etiolated plants. The question as to the correct theory of plant transpiration need not be further discussed here. I simply wish to show how Jumelle came to what I think are erroneous conclusions. Jumelle has lately been carrying on a controversy with Verschaffelt who maintains that ether increases transpiration in the dark as well as in the light. This Jumelle has attempted to disprove in his final paper on anæsthetized plants.

By way of criticism it must be pointed out that, in the first place, Jumelle as well as Verschaffelt used only portions of plants in their experiments and hence their conclusions are of little practical value. In the second place they very possibly confounded *evaporation* with *transpiration* as I shall attempt

to show. It is well known that dead plant tissue loses water vapor much more rapidly than living tissue. There can be no transpiration in dead tisue; it is evaporation, and that is a distinctively mechanical process. Transpiration takes place in living tissues only and is dependent upon protoplasmic action. Anything that reduces protoplasmic activity will therefore reduce transpiration.

II. Experiments on protoplasmic movements.

It has been known for some time that ether reduces the activity of animal protoplasm. Since all forms of protoplasm are supposed to be essentially alike it is to be expected that ether will have a similar effect upon vegetable protoplasm. For the purpose of studying the effects of ether vapor on vegetable protoplasm I used cross sections of the leaf, bearing hair cells, of *Primula sinensis*, *Petunia violacea*, and *Lycopersicum esculentum*. These sections were placed in a hanging drop of water without a cover glass, with a suitable arrangement to expose the preparation to the ether vapor at any desired moment. Only a very short period (2 or 3 seconds) was sufficient to cause the protoplasm to collect in spheroidal masses which after a shorter or longer period returned to the normal condition. The following are some of the results obtained.

Conditions of light, temperature, and moisture were constant in all the experiments.

1. *Primula sinensis.*

Numbers indicate time, in seconds, required for a certain protoplasmic granule to move 10μ.

First experiment.

Normal: 5, 4, 6, 5, 4, 5, 5, 4, 6, 5, 5, 4, 5, etc.
After momentary exposure to ether vapor, 4, 5, 5, 6, 6, 7, 6, 7, 7, 8, 8, 9, 9, 10, 10, 10.
Remained stationary at about 10 then returned to normal: 10, 9, 10, 9, 8, 8, 7, 7, 7, 6, 5, 5.

Second experiment; fresh sections.

Normal; 5, 6, 7, 5, 6, 5, 6, 5, 5, 6, 6, 5, 6, 6, 5, etc.
Exposed to ether vapor for 2 seconds; 6, 7, 7, 8, 9, 11, 11, 13, 14, 14, 15, 14, 14.
Remained stationary at about 14 then returned to normal: 14, 14, 13, 13, 12, etc.

2. *Petunia violacea.*

First experiment.

Normal: 6, 5, 5, 6, 6, 5, 5, 5, 6, 5, 6, 5, 5, etc.
Exposed to ether vapor for 4 seconds: 7, 8, 7, 8, 9, 10, 11, 11, 14, 15, 18, 19, 22, 40, 50, etc., until all motion permanently ceased.

Second experiment; fresh sections.

Normal: 5, 6, 5, 6, 5, 5, 6, 5, 6, 5, etc.
Momentary exposure to ether vapor: 5, 5, 6, 7, 7, 7, 8, 8, 9, 9, 8, 9, 8, 9, 8, 7, 7, 7, 6, 6, 5, 5.

Third experiment; fresh sections.

Normal: 5, 6, 7, 6, 6, 5, 5, 6, 6, 7, 6, 5, 6, etc.
Exposed to the ether vapor for one or two seconds: 5, 6, 6, 6, 7, 7, 7, 6, 7, 7, 8, 8, 9, 11, 12, 14, 15, 16, 16.
Remained stationary at 16 then returned to normal.

3. *Lycopersicum esculentum.*

Normal: 4, 5, 4, 5, 5, 4, 5, 5, 4, 5, 5, etc.
Momentary exposure to ether vapor: 4, 5, 6, 6, 7, 8, 10, 12, 14, 14, 15, 16, 16, 17, 17, 16, 17.
Then returned to normal.

From these experiments it will be seen that ether vapor reduced protoplasmic action, temporarily when exposed for a short time and permanently when exposed for a longer time. I might mention incidentally that ether vapor had no perceptible effect upon the position, size, or shape of the chlorophyll bodies.

III. Experiments on transpiration of entire plants.

Having noted the effect of ether vapor upon protoplasmic activity and believing that transpiration depends on protoplasmic activities, we may next proceed to the transpiration experiments proper. As already mentioned the experiments of Jumelle, and likewise those of Verschaffelt and Lommen, are really of little practical value because these investigators did not use the entire plant, root and all. In the following experiments I have employed a modified and improved Kohl transpiration apparatus which permits the use of the entire plant.[2]

Owing to the fact that this apparatus gives very delicate results and hence is easily influenced by slight changes of environment the following precautions must be observed in its use.

1. There must be no air bubbles in any part of tubes *b*, *h*, and *g*.[2]

[2] See plate VI and explanation.

2. The capillary tube, *h*, especially must be free from air-bubbles and other impurities.

3. All fittings to tube *b* must be air tight.

4. The tube *b* must be entirely filled with water.

5. The water used should be boiled to remove air.

6. The temperature of air and water must be stationary before observations are made.

7. Nothing must be placed in *b* that will generate gases, as culture fluids, etc.

8. The same plant must not be retained in tube *b* for more than 12 hours.

9. The water in tube *b* must be changed every time the plant is changed.

These precautions may assist in preventing faulty experimenting on the part of those who may not as yet have used a similar apparatus.

From a series of experiments I found that the daily period of maximum transpiration corresponds to the daily period of maximum growth (one to four o'clock P. M.). This seems to be additional evidence that transpiration depends upon assimilation.

I. RELATION OF LIGHT TO EFFECT OF ANÆSTHETICS.

The plant used in the following series of experiments was *Solanum tuberosum*. In all cases the plant was covered by the bell jar and dry air forced through by means of a pair of foot bellows. The air was dried by means of sulphuric acid and chloride of calcium. Of course the entire plant was used, root and all, care being taken not to mutilate the fine rootlets more than was unavoidable. No observations were made until the temperature of the air and water was nearly constant.

1. *Solanum tuberosum*, small plant, seven leaves, three small, developing tubers; in diffused light.

Time	Tem. of water °C.	Tem. of air °C.	Normal or Anaest.	Time in seconds required to evaporate 5mm of water column.	Average time.	Progress.
3:30	21½°	22⅔°	Normal	7, 7, 8, 7, 6, 8, 7, 7, 8, 7, 6, 7, 8, 7	7.2	Ether introduced
3:34	21⅓°	22½°	Ether.	7, 8, 7, 7, 6, 7, 8, 9, 9, 8, 9, 9, 10, 9 10, 11, 11, 11, 12, 12, 12, 13, 13	7.2–11.4	Ether removed.
3:50	21½°	22½°	Normal	12, 11, 12, 11, 10, 8, 7, 8, 7, 7, 8, 7	11.4–7.2	
4:20	21°	20½°	Normal	7, 7, 8, 7, 7, 8, 8, 7, 7, 7, 8, 7, 8, 7	7.3	Amyl nit. intr'ed
4:24	21°	20½°	Aml nit	7, 7, 8, 7, 7, 8, 7, 8, 8, 8, 7, 8, 8,	7.5	After 5 min. amyl nit. removed.
4:32	21°	20½°	Aml nit	12, 11, 12, 13, 13, 12, 14, 13.........	12.37	
4:45	20.5-6°	20¼°	Normal	13, 13, 12, 12, 13, etc. to normal.	12–7.5	End.

2. *Solanum tuberosum*, small plant, eight leaves, no tubers; in diffused light.

Time	Tem. of water °C.	Tem. of air °C.	Normal or Anaest.	Time in seconds required to evaporate 5mm of water column.	Average time.	Progress.
11	21⅔°	24.5°	Normal	10, 11, 11, 10, 12, 11, 10, 12, 11	10.8	Ether introduced
11:14	21⅔°	24.5°	Ether.	11, 11, 10, 11, 11, 12, 11, 12, 12	11+	After 10 minutes
11:18	21¼°	24.5°	Ether.	16, 17, 17, 16, 17, 17, 16, 18, 17	16 7-9	ether removed.
11:23	21¼°	24.5°	Normal	16, 16, 14, 13, 13, 12, 11, 10, 11	16–10	End.
Ether introduced and left until 2 P. M.						
2:00	23°	24.9°	Ether.	75, 73, 75, 72, 70, 73, 75	73	Ether removed
2:15	23°	24.9°	Normal	75, 70, 73, 71, 74, 73, 72, 70.........	72	after 10 min.
2:30	23°	24.9°	Normal	36, 35, 36, 32, 35, 34, 34	32.5	End.

It will be seen that the plant did not return to its normal transpiration after it had been exposed to ether vapor from 11:30 A. M. to 2:00 P. M. The ether had partially killed the plant as the subsequent drying up and shriveling of the tips and margins of some of the leaves served to indicate.

3. *Solanum tuberosum*, small plant, six leaves, no tubers; in direct sunlight.

Time	Tem. of water, °C.	Tem. of air, °C.	Normal or anæsthet.	Time in seconds required to evaporate 5mm of water column.	Average Time.	Progress.
2:30	22¼°	30°	Norm'l	5, 6, 5, 6, 5, 5, 6, 5, 6, 6, 5, 5......	6.1	Ether introduced
2:34	22¼°	30°	Ether ..	6, 5, 6, 6, 6, 7, 7, 8, 8, 9, 8, 9, 9, 9	6–9	Ether removed.
2:36	22¼°	30°	Norm'l	8, 8, 7, 6, 6, 5, 6, 5, 5, 6, 6, 5......	9–6	Chlorof'm int'ced
2:38	22¼°	30°	Chl'frm	5, 5, 6, 5, 6, 6, 5, 6, 7, 6, 7, 7, 8, 9	6–9—	Chlorof'm rem'vd
2:40	22¼°	30°	Norm'l	8, 8, 7, 7, 6, 6, 5, 6, 5, 5, 6, 5......	9–6—	

These experiments seem to show conclusively that a plant exposed to the vapor of ether, amyl nitrite or chloroform, will have its transpiration very materially diminished. I took no special notice of the amount of anæsthetic used because I soon found that the effect was the same independent of the quantity used. Of course a small quantity required a longer time to produce given effects. Ether and chloroform I poured in any vessel from which it could evaporate. Amyl nitrite was used by putting two or three drops on a piece of cotton under the bell jar. It will be remembered that during all these experiments a current of dry air was passed through the bell jar, carrying with it most of the vapor; still there was sufficient left to produce the given results. Exposing the plant to amyl nitrite vapor for ten or fifteen minutes was suf-

ficient to kill the greater portion of it. It could withstand a much longer period of exposure to ether and chloroform vapors.

The following set of experiments, 4 to 6, relate to the influence of anæsthetics on plant transpiration when the plant is exposed to the various colors of the solar spectrum. I found it rather difficult to obtain pure colors. The colors I desired were red, yellow and green. Red and green I was able to obtain quite pure; but it was impossible for me to obtain yellow that did not also transmit red. The following is a list of substances with result of spectrum analyses. The thickness of the liquid was in all cases 13^{cm}.

Color.		Dye used.	Rays transmitted.
Red.	1	Eosine	From 65 to 75.
	2	Carmine	From 66 to 73.
	3	Fuchsine	From 66 to 75.
	4	Safranine	From 67 to 75.
	5	Magdala red	From 64 to 75.
Yellow.	1	Methyl orange	From 56 to 75.
	2	Gold orange	From 58 to 75.
	3	Orange	From 57 to 75.
	4	"Diamond dye" yellow	From 55 to 75.
Green.	1	Iodine green	From 45 to 56.
	2	Methyl green	From 45 to 57, and 72 to 75.
	3	Malachite green	From 46 to 56, and 72 to 75.
	4	Alcoholic chlorophyll solution	From 40 to 70.
	5	Copper chloride solution	From 40 to 70.
	6	Diamond dye yellow and blue	From 49 to 56.
Black.	1	Diamond dye black	Faint trace of all rays.
White.	1	Water	All rays of solar spectrum.

From these and various other colors which I examined, I selected fuchsine for red; "diamond dye" yellow, for yellow; a mixture of diamond dye yellow and blue, for green. Of these I made watery solutions in large double-walled bell-jars that could be placed over the plant on the apparatus in place of the ordinary bell-jar. Diamond dyes have an advantage in that the watery solutions do not form a sediment like many of the aniline dyes; they seem also to fade less quickly.

The transparency of colored liquids was made approximately alike, likewise was the thickness of the liquids in the various jars, and different parts of the same jar only approximate. Owing to the fact that a complete series of experiments must

be made with the same plant at one sitting, and since the period of constant temperature and illumination during the day is short, I could not obtain such marked results as I could have obtained with longer periods of time. Also, the jars used were larger than the bell jars used in the second series of experiments; hence the effects of the anæsthetics did not appear as quickly, nor were the results so marked.

4. *Fuchsia* sp.? ; small, five leaves, small roots, no flowers.

Time	Color.	Tem. of liq. °C	Tem. of air °C.	Tem. of water °C.	Anaest. or normal	Time in seconds required to evaporate 5 mm of water column.	Progress.
3.00	White	23.5	24	22	Normal	15, 16, 15, 16, 16, 15, 16, 16, 15,	Ether iutr'd.
3:04	dif. l.	23.5	24	22	Ether.	15, 16, 17, 15, 16, 15, 16, 16	After 6 minutes
3:10	"	23.5	24	22	Ether.	17, 18, 18, 18, 19, 18, 19, 19, 18	ether removed.
3:16	"	23.5	24	22	Normal	15, 16, 15, 15, 16, 16, 16, 15, 16	4 minutes.
3:19	Dark.	23	24	22+	Normal	16, 15, 15, 16, 15, 16, 16, 13, 16	Dark.
3:34	"	23	24	22.25	Normal	18, 18, 19, 18, 18, 19, 18, 18, 19	Aft. 15 m. et. in'd.
3:36	"	23	24	22.25	Ether.	20, 18, 18, 18, 19, 19, 18, 19	Aft. 5 m. eth. rem.
3:42	"	23	24	22.25	Ether.	20, 21, 22, 21, 22, 21, 22	4 minutes.
3:49	"	23	24+	22.5	Ether.	18, 19, 18, 18, 19, 18, 19, 18, 18	End.

5. *Solanum tuberosum*, small plant, strong roots, no tubers.

Time	Color.	Tem. of liq. °C	Tem. of air °C.	Tem. of water °C.	Anaest. or normal	Time in seconds required to evaporate 5 mm of water column.	Progress.
11:20	White	21	22	20	Normal	10, 9, 10, 10, 9, 10, 9, 10, 10, 9	Ether intr'd.
11:22	dif. l.	21	22	20	Ether.	10, 9, 10, 10, 10, 9, 9, 10, 9, 10	After 8 minutes
11:30	"	21	22	20	Ether.	13, 12, 13, 13, 13, 12, 13, 12	ether removed.
11:35	"	21	22	20	Normal	10, 9, 10, 10, 9, 9, 10, 9, 9, 10, 10	Amyl nit. intr'd.
11:37	"	21	22	20+	Amyl n	10, 9, 10, 9, 10, 10, 10, 10, 9	After 3 minutes
11:41	"	21	22+	20	Amyl n	13, 13, 12, 13, 13, 13, 12, 13	amyl n. removed.
11:46	"	21	22	20	Normal	10, 9, 9, 10, 10, 10, 9, 10, 9, 9	
11:48	Dark.	21.5	22	20	Normal	10, 9, 10, 9, 10, 10, 9, 10, 10, 9	Dark.
12:02	"	21	22	20	Normal	12, 12, 12, 13, 12, 12, 13, 12	After 15 minutes
12:05	"	21	22	20	Amyl n	12, 12, 12, 13, 13, 12, 13, 12	amyl nit. intr'd.
12:11	"	21	22	20	Amyl n	14, 13, 13, 14, 14, 15, 14, 14	Af. 5 m. am'l rem.
12:16	"	21	22	20	Normal	12, 13, 12, 13, 13, 12, 13, 12	End.

These experiments show that ether as well as amyl nitrite reduces transpiration both in light and dark. I was very careful to have conditions of temperature and moisture the same in all cases. The above are only a few of a large number of similar results obtained. Variation in temperature, etc., caused me to repeat many of the experiments before I obtained satisfactory results.

The following is a series of experiments in which I used colored liquids, namely red and green, which were almost pure as seen from the table of spectrum analysis, and yellow which transmitted a trace of green, all the yellow, orange and red. To make the series complete I also repeated the experiments with white light and in darkness.

Without going into the discussion in regard to the influence of colored light on plant transpiration and assimilation, I will give the average results obtained from a series of experiments. The conditions of temperature and moisture were constant in all cases.

White light, diffused, required	54	seconds to evaporate	25	mm.
Yellow " " "	60	" "	25	"
Red " " "	62	" "	25	"
Green " " "	64	" "	25	"
Darkness "	72	" "	25	"

The results obtained agree quite closely with those obtained by Déhérain, Engelmann and Kohl. Timiriaseff and Engelmann maintain that there is another position of maximum assimilation and transpiration in the blue; leaving that out of the question, I think that nearly all plant physiologists affirm that assimilation and hence transpiration is most active in the more luminous rays of the solar spectrum.

6. *Solanum tuberosum*, small plant, strong roots, no tubers.

Time	Color.	Tem. of liq. °C	Tem. of air °C.	Tem. of water °C.	Anaest. or normal	Time in seconds required to evaporate 5 mm of water column.	Progress.
11:30	White	21.5	22	21.5	Normal	11, 11, 11, 10, 11, 11, 10 10, 11, 11, 10	Ether introduced
11:34	dif. l.	21.5	22	21.5	Ether.	11, 11, 11, 12, 11, 10, 11, 11, 11, 12	After 10 min.
11:46	"	21.5	22	21.5	Ether.	13, 14, 13, 13, 14, 13, 14, 14 14	ether removed.
11:49	"	21.5	22	21.5	Normal	11, 11, 11, 10, 10, 11, 10, 11, 11, 11	Yellow l.
11:53	Yellow.	21	22	21.5	Normal	11, 11, 11, 10, 11, 11, 11, 11, 10, 11, 11	After 10 min.
12:04	"	21	22	21.5	Normal	12, 11, 12, 13, 12, 11, 12, 11, 13	ether introduced
12:10	"	21	22	21.5	Ether.	15, 14, 14, 15, 14, 14, 15, 14	Ether removed.
12:20	"	21	22	21.5	Normal	12, 11, 12, 12, 11, 12, 12, 11, 12	Red l.
12:25	Red.	21.5	22	21.75	Normal	12, 11, 12, 12, 11, 12, 11, 12, 13	After 10 min.
12:38	"	21.5	22	21.75	Normal	12, 13, 13, 12, 13, 13, 12, 13, 13	ether introduced
12:45	"	21.5	22	21.75	Ether.	15, 16, 16, 15, 15, 16, 16, 15, 16	Ether removed.
12:49	"	21.5	22.25	21.75	Normal	12, 13, 12, 13 13, 12, 13, 12	Green l.
12:52	Green.	21	22.25	21.75	Normal	12, 13, 12, 13, 13, 12, 13, 12, 13	After 15 min.
1:00	"	21	22.25	21.75	Normal	13, 13, 14, 13, 14, 14, 13, 12, 13	ether introduced
1:15	"	21	22.25	21.75	Ether.	16, 17, 16, 17, 16, 17, 16, 16, 17, 17	Ether removed.
1:25	"	21	22.25	22	Normal	13, 13, 14, 13, 13, 13, 12, 14, 13	Dark.
1:36	Dark.	21.5	22.5	22	Normal	13, 12, 13, 14, 13, 13, 12, 14, 13	After 30 min.
2:08	"	21.5	22.5	22	Normal	14, 15, 14, 14, 15, 14, 15, 14	ether introduced
2:20	"	21.5	22.5	22	Ether.	16, 17, 19, 18, 19, 17, 18, 18, 19	Ether removed.
2:26	"	21.5	22.5	22	Normal	14, 15, 14, 14, 13, 14, 14, 13, 14	End.

I experimented also with *Fuchsia* and *Geranium* with the results given above. These experiments indicate that the different colors of the spectrum do not affect the influence of ether vapor on plant transpiration.

II. RELATION OF ATMOSPHERIC MOISTURE TO INFLUENCE OF ANÆSTHETICS.

Atmospheric moisture does not affect the influence of ether vapor on transpiration, as the following experiments show. Kohl claims that transpiration is zero in the saturated atmos-

phere. I can not agree with him. Of course any one knows that in a saturated atmosphere moisture can not be given off as vapor. That would be a mechanical impossibility. It is also quite difficult to saturate an atmosphere evenly and completely with moisture. A bell-jar was not equally warm on all sides under the most favorable circumstances I could bring to bear upon it. At no time did transpiration approach zero after all the conditions of the experiment had been properly accounted for. In the following experiments the plant was exposed to diffuse sunlight.

1. *Solanum tuberosum;* small plant, strong roots.

Time	Tempe'ture Air °C.	Tempe'ture Wat'r °C	Condition of atmosphere.	Anæst. or normal	Time, in seconds, required to evaporate 5^{mm} of water column.	Progress.
3:00.	24.5	24°	Dry	Normal	7, 8, 7, 7, 8, 7, 7,8,7,8,7,7 8,7,7,7,8	In sat. atm'e
3:04	24.5	24°	Gradu'lly saturat'd	Normal	7,8,7,7 8,8,7,8,8,7,8,8,8,9,8,9,9......	After 5 min.
3:10	24.5	24°	More saturated.......	Normal	10,10,11,10,11,11,11,12,11,12,13,13	After 10 min.
3:25	24.5	24°	More saturated	Normal	24, 24, 25, 26, 27, 29, 32, 35, 34.....	After 1 hour
4:30	24	23°	Practically satur'td	Normal	34, 36, 35, 36, 34, 32, 36, 37, 35.....	exp'd to ether
4:45	24	23°	Practically satur'td	Ether...	35, 38, 49, 64, 68, 78, 82, 84.........	Eth. remov'd
5:00	24—	22¾°	Practically satur'td	Normal	34, 35, 35, 36, 32, 35, 36, 34, 35.....	End.

2. *Fuchsia* sp. ?; small plant, strong roots, no flowers.

Time	Tem. air. °C	Tem. water °C	Condition of atmosphere.	Anæst. or normal	Time in seconds, required to evaporate 5^{mm} of water column.	Progress.
10:15	21.5°	20°	Dry	Normal	9,8,8,9,8,9,8,8,9,9,8,9,8,9,8,9, 8.8	Plant moistened.
10:20	21.5	20	Part. sat'd.	Normal	14,14,15,14,15,15,16,16,18,17,18,19	After one hour
11:30	22	21.5	Prac. sat'd.	Normal	32, 31, 33, 31, 30, 33, 31, 32, 30,33	ether introduced.
11:40	22	21.5	Prac. sat'd.	Ether...	60, 66, 64, 67, 70, 68, 70, 74, 78.....	Removed.
12:00	22.5	22	Prac. sat'd.	Normal	30, 31, 32, 30, 32, 31, 32, 30, 31.....	Amyl n. introduced
12:15	22.5	22	Prac. sat'd.	Amyl n.	75, 64, 70, 76, 74, 70, 75, 76, 74, 71	Amyl n. removed.
12:30	22.5	22.5	Prac. sat'd.	Normal	33, 32, 34, 31, 32, 31, 34, 32, 33.....	End.

These experiments showed that moisture did not affect the influence of ether and amyl nitrite vapors on plant transpiration.

IV. Experiments on transpiration of leaflets.

Finally, to show the cause of Jumelle's apparently erroneous conclusions, I made a series of control experiments with *Solanum tuberosum* leaflets. There is no mechanical difficulty in performing these experiments, but they require close observation to avoid mistaken conclusions. The object of these experiments was to find the loss, in weight, of water in potato leaflets exposed to ether vapor in diffuse light and darkness. Jumelle states that he used the "branches" of various

plants in his experiments. Now it is in reality impossible to secure two branches from different plants (same species), or even the same plant, that are in all respects alike as to function and age, and which have been exposed to the same environments during life. To avoid these difficulties I observed the following precautions:

1. *Solanum tuberosum* leaflets were used.

2. Leaflets of the same leaf were used thus securing those of the same age, which had been exposed to the same external environments as nearly as possible.

3. The conditions of temperature and moisture were the same for all leaflets.

4. Only healthy looking leaflets were used.

5. Great care was observed in the handling of leaflets so as not to bruise them.

6. The petiole was cut straight across as near to the midrib as possible.

These leaflets were then weighed and placed on equal sized and seasoned pine blocks to keep them from the colder surface of the ground glass plate on which the blocks were placed. A well-fitting bell-jar was placed over each. Two leaflets were placed under normal bell-jars, two under dark bell-jars, blackened on inside with camphor soot. Two leaflets, one in the dark, the other in diffuse light were exposed to ether vapor evaporating from a flat dish, care being taken to have the same amount of ether in both cases in the same experiment. The following are the results:

1. Time of first exposure of leaflets, $1\frac{1}{2}$ hours.

Condition of light.	Anaesthet. or normal.	Weight in mg. before exposure.	Weight in mg. after exposure.	Loss in mg.	Per ct. loss.
Diffused	Ether	126	117	9	7.14
Diffused	Normal	130	120	10	7.69
Dark	Ether	131	124	7	5.34
Dark	Normal	136	128	8	5.89

The same leaflets were again weighed after having been exposed for 6 hours.

Diffused	Ether	126	58	68	54
Diffused	Normal	130	87	43	33
Dark	Ether	131	71	60	36
Dark	Normal	136	96	40	29

During the first period of exposure the ether had reduced *transpiration* and hence reduced the loss of moisture.

In the second period of exposure the ether had killed all the protoplasm and hence *evaporation* took place and not *transpiration*, which accounts for the increased loss in weight.

2. Time of first exposure, ½ hour.

Condition of light.	Anaesthetic or normal.	Weight in mg. before exposure.	Weight in mg. after exposure.	Loss in mg.	Loss per ct.
Diffused	Ether	51	50	1	1.9
Diffused	Normal	75	70	5	6.6

Conclusion: Ether retards transpiration in diffused light.

3. Time of exposure, 1½ hours.

Diffused light	Ether	236	223	13	5.5
Diffused light	Normal	203	191	12	5.9

Conclusion: Ether retards transpiration in diffused light.

4. Time, ⅔ hour.

Diffused light	Ether	45	43	2	4.4
Diffused light	Normal	57	54	3	5.2
Darkness	Ether	47	45	2	4.2
Darkness	Normal	32	30.5	1.5	4.7

Same leaflets weighed after 3 hours.

Diffused light	Ether	45	34	11	26.6
Diffused light	Normal	57	45	12	21
Darkness	Ether	47	35	12	25.5
Darkness	Normal	32	26	6	18.7

Conclusion: Ether retards transpiration in diffused light.

5. Time of exposure, 3½ hours.

Diffused light.	Ether	90	67	23	25.4
Diffused light.	Normal	75	56	19	25.25
Dark	Ether	84	57	27	32
Dark	Normal	93	74	19	20.43

Conclusion: Owing to the long period of exposure the ether had stopped protoplasmic activities, and hence increased evaporation in both cases, but most in the dark, because leaflets in the dark were killed first.

6. Time of exposure 1 hour.

Diffused light.	Ether	64	57	7	10.9
Diffused light.	Normal	57	61	7	12.2
Dark	Ether	68	61	7	10.2
Dark	Normal	48	43	5	10.4

Conclusion: Ether retards *transpiration* in both light and dark.

V. Summary.

1. Ether retards protoplasmic action. Given in sufficient dose it kills protoplasm.
2. Ether retards transpiration by retarding assimilation.
3. Anything that retards assimilation will retard transpiration.
4. Increased loss of water vapor in the anæsthetized vegetable tissue is due to the fact that the anæsthetic has killed the plant tissue, thus allowing *evaporation* to take place, and not *transpiration.*
5. Ether retards transpiration under all conditions.
6. Transpiration is not essentially a chlorophyllian function.
7. Experiments in which the entire plant is not used are practically valueless.
8. Periods of maximum growth and maximum transpiration coincide.

VI. Bibliography.

Berthold: Studien über Protoplasma-Mechanik, 1886.
Boehm: Ber. d. deutsch. bot. Ges., heft 9, 1890.
Bokorny: Ber. d. deutsch. bot. Ges., heft 1, 1891.
Bokorny: Flora, heft 3, 1890.
Detmer: Ber. d. deutsch. bot. Ges., heft 8, 1890.
Frank: Pflanzenphysiologie, 1890.
Goodale: Physiological Botany, 1885.
Hartig, Theo.: Anatomie und Phys. der Pflanzen, 1878.
Hartig, R.: Anatomie und Phys. der Pflanzen, 1891.
Janse: Flora, heft 4, 1889.
Jumelle: Rev. Générale de Bot., no. 1, 1889.
Jumelle: Rev. Générale de Bot., no. 22, 1890.
Jumelle: Rev. Générale de Bot., no. 31, 1891.
Kohl: Die Transpiration der Pflanzen, 1886.
Lommen: Botanical Gazette, no. 1, 1891.
Palladin: Ber. d. deutsch. bot. Ges., heft 10, 1890.
Pfeffer: Pflanzenphysiologie, 1881.
Pringsheim: Lichtwirkung und Chlorophyllfunction, 1881.

Sachs: Physiology of Plants, 1887.
Schimper: Bull. Tor. Bot. Club, no. 7, 1891.
Stich: Flora, heft 1, 1891.
Strasburger: Bau und Verricht. d. Leitungsbahnen, 1891.
Vines: Physiology of Plants, 1886.
Volkens: Ber. d. deutsch. bot. Ges., heft 4, 1890.
Wiesner: Ann. des Sciences Nat., 1876.
Wiesner: Ber. d. deutsch. bot. Ges., heft 2, 1891.

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EXPLANATION OF PLATE VI.

a, stand made of well seasoned heavy oak. All the wood work is thoroughly soaked in hot paraffine to make it impervious to water.
b, a glass tube filled with water in which is placed the root of the plant experimented upon.
c, block of wood to hold *b* in its place.
d, rubber stopper fitting into *b*, with two openings, one for bent glass tube connected with *e* and the other for bent glass tube connected with *v*.
e, rubber tube connecting glass tube *g* with bent tube in *d*.
f, bent glass tube connected with capillary tube *h*.
g, glass tube closed at distal end. This is to regulate the position of the water column in *h*.
h, fine capillary tube connected with *f* and from which the observations are made.
i, heavy glass plate with ground surface.
j, glass tube passing through opening in *i* and wood work, connected with *z*.
j', rubber stopper in upper end of *b*, perforated to admit stem of plant experimented upon. An incision is made from surface to central perforation to admit plant.
k, bell jar.
l, rubber stopper, with two openings.
m, thermometer to register temperature of atmosphere in *k*.
n, bent glass tube to give exit to atmosphere.
o, sulphuric acid bottle to dry atmosphere before it is passed through *k*.
p, calcium chloride tube to assist in drying air.
q, rubber tube connected with *o* and an aspirator, hand- or foot-bellows.
r, small vessel containing water to be taken up by *h* when no observations are made.
s, metric scale on which to observe the rate of movement of water column in *h* while transpiration is going on.
t, an ordinary Mælzel metronome regulated to beat seconds to assist in making observations.
u, clamps to hold block *c* firmly in place.
v, small rubber tube to connect *f* with *h*.
w, perforated stoppers to hold a small thermometer in place. Above upper stopper should be placed a little cotton to act as a fitter to prevent sand, dirt, etc., from getting into *h*.
x, clamps to hold *p* in place.
y, rubber tube connecting *o* with *p*.
z, rubber tube connecting *p* with *j*.

Root in tube *b* is to be protected against direct sunlight and sudden changes of temperature by means of a black silk cloth and heavy pasteboard shields. Slight changes of temperature have but little effect on water because its coefficient of expansion is comparatively low. Bubbles of gas, however small, are very susceptible to changes of temperature, and make their presence known by the fluctuations of the water column in tube *h*.

BRIEFER ARTICLES.

Notes on a variety of Ampelopsis quinquefolia.—For the past ten years I have been observing a variety of the Virginia creeper that is quite marked by characteristic points of difference from the type species. Other students of botany must have noticed this variation and it is strange if nothing has been published upon the subject, but thus far I have failed to find anything[1]. My attention was first called to the variation by neighbors who had transplanted the Virginia creeper from the woods but complained that it failed to cling to the side of the house. That was in the Miami valley in Ohio. I have since observed it in southern Iowa and in eastern Kansas. It does seem to me that the peculiarities are sufficient to distinguish it as a permanent variety and it should be so recognized in our manuals.

In the first place the habit of growth is quite different from the type species. As is well known this latter climbs by clinging very closely to its support whether that be a tree or a wall. The variety does not cling so closely to its support. In fact it is impossible for it to climb a wall or even a tree unless the bark be very rough, owing to the structure of its tendrils. It climbs more like the grape and the clematis by trailing over low shrubbery to that which is higher, until it may reach the lower branches of a tree when it may rise to a considerable height by reaching from branch to branch rather than by clinging close to the body of the tree and larger branches.

Sometimes in transplanting the Virginia creeper this variety is hit upon and the unobserving wonder why it fails to cling to the side of the house. On examination the tendrils will be found to be more like grape tendrils, long curling and grasping by recurved tips, rather than short, digitate and clinging by disk-like expansions as in the case of the typical species. The leaves also differ quite perceptibly, being much larger for the same age in the variation, and having longer petioles both for the leaf proper and for the leaflets. The margins are more distinctly serrate with larger teeth. The internodes of the stem are much longer in the variety, causing the leaves to be fewer and more scattered. The nodes are more swollen as are the leaf petioles at the base, making a much larger leaf scar, but the axillary buds are smaller.

The stem of the type species is quite rough, furrowed and warty, especially as it grows older, while the variety is much smoother. The fruit of the variety is more abundant, berries larger and in more open corymbs.

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[1] [See W. R. Lazenby in this journal XIII. 233 and XV. 233.—EDS.]

In short the whole aspect of the variety is more grape-like and for this reason I suggest the name *A. quinquefolia*, var. vitacea.—E. B. KNERR, *Midland College, Atchison, Kansas.*

Miscellaneous notes.—In May, 1892, I collected specimens of *Oxalis acetosella* L. having the whole blossom the same reddish color that usually veins the petals. These specimens were found in only one place on the western side of the Green mountains, just east of Manchester, Vermont.

I have found *Hypericum Canadense* L. var. *majus* Gray, very abundant in southern Vermont.

I have found Vermont specimens of *Scutellaria lateriflora* L. to be slightly pubescent as a rule. The corolla of my Vermont specimens of *Stachys aspera* is also slightly pubescent.

Prof. Burrill in the Bulletin of the Illinois State Laboratory of Natural History, II, 408, describes the Illinois specimens of *Uncinula circinata* C. & P. as "hypophyllous." In Vermont specimens I find that quite a percentage of diseased leaves have the fungus on the upper as well as the under side. In the same article, p. 419, he says of *Microsphæra erineophila* Peck: "This peculiar species is not uncommon in southern Illinois. So far as is known it has not been collected elsewhere." I had the good fortune to find a very limited amount of the above mentioned fungus in Newfane, Windham co., Vermont, in October, 1892.

I have found a few parasitic fungi on hosts not in Farlow & Seymour's "Host Index." *Phylactinia suffulta* (Reb.) Sacc. seems to have no choice of hosts whatever, provided that moisture and a little nourishment be furnished. I found it on the following additional hosts: Hamamelis Virginiana, Fraxinus Americana, Betula lutea, Alnus incana. On September 23, 1892, I placed specimens of *Phylactinia suffulta*, found on leaves of Fraxinus Americana, in a book to dry. There were so many specimens in the book that they kept it moist most of the time and I neglected to thoroughly dry it for nearly three weeks. On October 13th I found nearly mature perithecia of Phylactinia suffulta scattered all over the pages of the book and the label, which I had placed with the specimens. By applying KOH to the paper and scraping, threads of mycelium were obtained, showing that the fungus had grown on the damp paper. The asci were formed at the time I examined the plant but no spores. A similar thing took place with another set of P. suffulta specimens that were kept slightly moist for a time.

Microsphaera Alni (DC.) Winter was collected in Newfane, Vermont, on Betula lutea and Ostrya Virginica. *Uromyces Hyperici* was found in

the same locality on Hypericum Canadense var. majus.—A. J. GROUT, *Johnson, Vermont.*

EDITORIAL.

Of the new fields of botanical research developed in the last few years none have shown more rapid extension and greater economic importance than the study of that class of plant diseases due to parasitic bacteria. The first instance of such a disease was brought to notice in 1880 by Burrill, of Illinois. The disease of pomaceous trees, the cause of which he discovered, best known under the name of pear blight, remains at the present time the most fully investigated disease of its class.

In 1884 DeBary published his work entitled Morphologie und Biologie der Pilze, Mycetozoen und Bacterien, and in a brief paragraph on bacterial parasites of plants says they have scarcely been observed, and offers the suggestion that the acidity of the cell sap may partially explain their rarity. Probably no mention of the matter would have been made if the account of the yellow disease of hyacinths, with which bacteria are concerned, and which Wakker brought to light the preceding year, had not come to DeBary's attention.

In 1887 DeBary published his lectures on bacteria, which still remains one of the best works we possess on the general biology of this group of organisms. In this work he gave several paragraphs to the subject, mentioning the two diseases already named, and two or three other doubtful kinds, and appears to hold the view that in no case is the actual parasitic nature of bacteria established, so far as vegetable hosts are concerned. He closes the subject, and at the same time his series of lectures, with the statement that "bacteria are not objects of great importance as contagia of diseases affecting plants." This was the opinion of the best informed writer six years ago, and it has not been modified in any general treatise since that time.

Within the last six years, however, the number of discoveries in this line have been astonishingly large, and it is now evident that it has not been so much the scarcity of the diseases as the scarcity of the right kind of investigators, which has kept the subject obscure. The diseases have been all about us, but they have not been recognized.

The larger part of the advance so far made is due to American activity. Well defined diseases of tomatoes, potatoes, melons, oats, corn, sorghum, beans, beets, carnations, violets, pears and apples, and possibly others, are already known, and still more have been suggested as probably of bacterial origin.

Such diseases are often of the most virulent and destructive character, as pear blight and tomato blight; or they are wide spread and exceedingly harmful by decreasing the yield, although not killing the plant or producing marked changes in it, as the bacterial disease of oats. This latter class is not recognized as disease by the cultivator.

The literature of this subject is much scattered, and unusually fragmentary. Few of the diseases have been systematically investigated, and not one has been fully worked out. The life history of the parasite in every case still demands attention, and even the nature of the parasitism itself would be a fruitful field for study. Nevertheless, were what is already known of the subject put together, it would form a fair sized volume.

There can be little doubt that what has so far been discovered is but a beginning. The results are likely to be eventually quite as extensive and important as in animal pathology, except in so far as the latter directly affects or coincides with human pathology.

What is especially needed at this stage of advancement is the continuous and systematic examination of the whole ground by one or more well equipped investigators, and the publication of a critical statement of what may be safely accepted as proven. Even a summarization of the present status of the subject, without critical laboratory study, would be helpful, if well done.

CURRENT LITERATURE.

Biology in an attractive form.

Gibson's recently published work, which he has called "Sharp Eyes,"[1] is an admirable piece of book making, from whatever point of view considered. The work conveys much interesting, curious and useful information about plants and animals, is written in choice language, in direct narrative style, and of high literary quality, and is profusely illustrated with spirited glimpses of nature, most delicately and artistically drawn.

The author has, indeed, "sharp eyes," not only to see small objects, but to penetrate their meaning. He looked at "things not rare, nor seclusive, nor foreign, things which are to be found in almost any of our woods, or fields, or copses; and which any wide-awake saunterer

[1] GIBSON, WM. HAMILTON.—Sharp Eyes, a rambler's calendar of fifty-two weeks among insects, birds and flowers. Roy. 8vo. Harper & Brothers, New York, 1892. pp. 322. Illust. $5.00.

may discern." Every chapter is filled with interesting matters about these common objects, which will be largely new to the reader, whether young or old.

The author is equally familiar with the peculiarities and habits of flies, wasps, toads, squirrels, flowers, germinating seeds, pine cones, exploding pods, sleeping leaves, etc., and he studies them not as animals or plants, but as natural objects having an interesting history and curious behavior.

There is a division of the work for each week in the year, beginning with March. The first chapter deals with the flowers of the skunk-cabbage, the next with the behavior of maple seeds. the next with Pickering's frog, then antics of opening cones, and the ingenuity of squirrels. and so on for the fifty-two divisions.

Although the author writes popularly and mainly for young people, he does not sacrifice accuracy, and often supplies the Latin names when the common ones do not suffice for identification. Among the fungi only does he appear wanting in scientific information, e. g., regarding fairy rings and the exobasidium excrescences on Azalea.

But the best feature of this work is yet to be mentioned. There is an atmosphere pervading its every line that makes the reader feel that the chief advantage is to be gained by hunting up these and similar curious things himself. Herein the author has rendered a distinctively scientific service to biology. If boys and girls were trained in biology and biological methods of this kind, the oft made remark that the botany and zoology which a pupil knows when he comes to college are usually hindrances to his further progress in those studies would no longer be true, and much of the effort of the college teacher in training young men and women for investigators would be uncalled for.

A text-book of botany for pharmacy students.[1]

In this new text-book we have no decided departure from previous ones. It is, however, a compact and well balanced presentation of the facts of botany which it is most important for students of medicine and pharmacy to know. If any criticism upon the balance of parts is to be made, there seems to us too much space devoted to the presentation of the classification of plants; but perhaps, considering the predominant place which this part of the subject has always held in the instruction imparted to such students, this book makes as great an advance as ought to be expected. For only one-third of the space is so used,

[1] WARNECKE HERMANN:—Lehrbuch der Botanik für Pharmaceuten und Mediciner; Einführung in das Studium der Pharmakognosie des Pflanzenreiches. 8vo. pp. xii. 364. figs. 338. Braunschweig: Harald Bruhn. 1892.

and much of the morphology is really found in this section. The preceding 226 pages are devoted to an exposition of the external morphology of plants; an introduction to microscopic technique and vegetable anatomy; and an account of the structure of some of the more important drugs.

The morphology of the vegetative organs of the lower plants is dismissed with a few pages, a treatment which is only justifiable in consideration of the small part these plants play in medicine. Even from this point of view, it might well have been longer; what there is is good. The discussion of the morphology of the members of the higher plants is a compact and clear presentation of, for the most part, modern ideas, with comparatively few survivals of useless terminology. We cannot say so much for the account of the morphology of the flower of angiosperms in the systematic part, where Dr. Warnecke does not seem to be so much in touch with modern conceptions.

The section on anatomy (leaving out of the special anatomy of the selected drugs, regarding which we are not competent to express an opinion) is again a well selected and well arranged compendium of the elements of histology. Dr. Warnecke has shown good judgment in what he has put in and what he has left out. The treatment of secondary thickening, for example, so important for an understanding of the structure of most of the barks, stems, rhizomes and roots which come into use as drugs, is full and yet concise, though we do not approve of the way in which it is distributed amidst the special descriptions of these parts.

The illustrations throughout are for the most part original, sometimes too mathematical, but are excellently engraved and printed. The book really deserves translation into English for American students.

Minor Notices.

BULLETIN 45 of the Cornell University Agricultural Experiment Station treats of the cultivation of tomatoes. Bulletin 46 of the same station gives an account of the cultivated forms of mulberries and their specific relations. Sixteen varieties are mentioned as fruit bearing, of which the New American is recommended. These sixteen varieties belong to five more or less distinct general types or species, Morus alba, M. latifolia, M. Japonica, M. nigra, and M. rubra. The latter, our native species, Professor Bailey looks upon as the probable progenitor of the American mulberries of the future.

IN ITS BEARING on the feeding of plants, investigation of the physics of the soil is of prime importance. Those who are interested in plant physiology should therefore take note of the recent work of F. H.

King, Professor of agricultural physics in the University and Physicist of the Wisconsin Agricultural Experiment Station.[1] For a considerable time Professor King has been studying the effect of various superficial causes upon the level of the water in the interstices of the soil. He has not only discovered a number of curious variations in this "water table," but has devised several ingenious pieces of apparatus for studying the complicated problems which presented themselves, and has been able to ascertain many of the relations between barometric pressure, rain-fall, temperature, seismic vibrations, cropping, manuring, etc., and the level of the ground-water. For details we must refer our readers to the papers themselves.

THE LIST OF mosses included in the catalogue of the flora of West Virginia by Millspaugh (see this journal XVIII, 34) has been separately issued as Contribution No. 32, from the Herbarium of Columbia College. Two new species of Dicranodontium are described, with excellent plates, *D. Virginicum* and *D. Millspaughii.* The latter is *Campylopus flexuosus* Sull. (non Brid.). Eighty-four species and varieties are enumerated.

A. S. HITCHCOCK, Professor of botany in the State Agricultural College of Kansas, has issued a useful descriptive list of the species and key to the genera of the "Woody Plants of Manhattan in their Winter Condition."[2] The list contains sixty-three native and four commonly cultivated species that have escaped. It was prepared originally for the use of the author's students. The nomenclature follows the Rochester agreement, and the sequence that of Gray's Manual.

OPEN LETTERS.

Is Polyporus carnivorous?

The article in the November GAZETTE entitled, "*A probable new category of carnivorous plants*," was read with much interest, although it seems to me that there should be considerable hesitation in accepting Prof. MacMillan's interpretations of the facts, for the following reasons:

1. The flies frequently found on the under surface of *Polyporus applanatus* do not seem to be there from any special preference for the

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[1] KING, F. H.:—Investigations relating to soil moisture. Extracted from the eighth annual report of the Wis. Ag. Exp. Sta., pp. 91–134. Also: Observations and experiments on the fluctuations in the level and rate of movement of ground-water on the Wis. Agric. Exp. Sta. farm and at Whitewater, Wis. U. S. Dep't of Agric., Weather Bureau, bulletin No. 5. Washington, 1892.

[2] Copyrighted and published by the author, Manhattan, Kansas. 8vo. pp. 20.

fungus, but are evidently searching for roosting-places, and may be found in equal numbers on the under surfaces of logs raised from the ground or in any sheltered nooks. Professor MacMillan has noticed that the flies are more abundant, "notably in the evening or toward the middle of the afternoon," and also says, "I have not been able to discover any secretion that might be attractive to the insects given off by the plant, but there may be such."

2. It is not evident that the fungus either catches or kills the flies. Searching for Myxomycetes and Hepaticæ has led me to notice more particularly the fact that small dead flies and other insects are sometimes very abundant in the roosting-places mentioned above, wherever they can hang suspended from a horizontal surface, the position apparently most restful to the insect anatomy, and where the feebler individuals die from cold in t e night. How flies with their feet caught in the pores of a *Polyporus* come to lie "flat upon the hymenophore surface," is not plain. One would expect them to hang suspended by their legs, which is usually their position.

3. The fact that the dead insect is soon overgrown by hyphæ of the fungus does not bear directly upon the question, for the growing hymenophore of species of *Polyporus* will spread itself upon almost any foreign body with which it happens to come in contact. When a growing specimen of *P. applanatus* meets with a stem of a living herbaceous plant it spreads over the surface of the latter, and finally encloses it, so that the stem occupies a cylindrical passage up through the fungus. The borders of the lower end of this hole are extended downward along the plant stem, sometimes for a considerable distance below the general plane of the under surface of the specimen. When the foreign body is of small size it is soon completely enclosed in the substance of the fungus. On railroad ties fungi frequently have both upper and lower surfaces covered with elevations and protuberances like those described by Prof. MacMillan, which on investigation may be seen to inclose small bits of coal and cinders. On cutting through such a specimen similar pieces of mineral matter may be found anywhere in its substance.

That the projections formed over the dead flies is white like the growing borders of the hymenophore is very probably due to the fact that in both places the hyphæ are more flocculent, and less closely matted together.

4. That the remains of the insect are not a lasting impediment to the formation of pores does not necessarily imply digestion, for when a small fly has died and dried up, very little solid matter remains to impede anything. In the case where solid particles are enclosed by the fungus a thick layer of hymenophorous tissue is put on, and pores are formed in this just as though no foreign substance were present above them. The parts of the dead fly are ramified and encased by the filaments of the fungus, and when these last arrange themselves to form the usual porous structure it would not be strange if the fly were lost to sight.

5. To say, "It is unquestionably true that the plant derives some nutriment from these flies, for where they fall and raise the surface of the hymenium there are more pores produced than at other points of similar size," appears, to say the least, unwarrantable in view of the

fact, above stated, that the surface, and consequently the number of pores, is increased when the growing hymenophore comes in contact with foreign substances which are not and cannot be digested by the fungus.

It is not intended above to maintain that *Polyporus applanatus* does not digest and get nutriment from the small dead flies, but that the methods of growth of this and allied species are such that the reasons enumerated in Professor MacMillan's article do not seem sufficient to warrant the inference of a carnivorous habit.

There is, however, a fact suggesting that the hyphæ of the fruiting body of *Polyporus* are sufficiently different from those of the vegetative portion not to be concerned with nutrition or digestion. When two logs lie within a few inches of each other and a sporophore of *Polyporus applanatus* grows out of one log and across to the other, it may spread itself out somewhat upon the latter, but its hyphæ do not seem to penetrate, even in cases where the logs are of the same species and in the same stage of decay. Again, a rotten leaf plastered against the growing hymenophore seems to be a serious obstacle to growth. Instead of sending in hyphæ and digesting the leaf, the latter is covered from the edges as any perfectly indigestible substance would be, or if the leaf be too large the growth of the portion covered is abandoned. And yet, *a priori* reasoning would lead us to suppose that a rotten leaf would be more readily dealt with than a fly, being more nearly like the usual food of the fungus.

Indeed, the very fact that the species of parasitic and saprophytic fungi show such decided preference for certain hosts is an important reason for doubting that *Polyporus applanatus* makes active use of animal nourishment.—O. F. Cook, *Huntington, N. Y.*

NOTES AND NEWS.

Garden and Forest says that the tallest trees in the world are in the gullies of Victoria, one of which is 471 feet high.

Beloit College has recently dedicated a new building known as Pearsons' Hall of Science, in which admirably arranged botanical laboratories find a conspicuous place.

Dr. William Trimen, director of the Royal Botanical Gardens of Ceylon, is preparing a "Handbook to the Flora of Ceylon," which will be issued soon by Dulau & Co., London.

Jars containing the tubercle-bearing roots of about forty species of North Dakota Leguminosæ will be shown at the World's Fair by Prof. H. L. Bolley, of the State University at Fargo.

The botanical seminar of the University of Nebraska has organized an exchange club for the purpose of facilitating exchanges among collectors in Nebraska and rendering them more satisfactory.

The monumental work by Engler and Prantl, entitled "Die Natürlichen Pflanzenfamilien" will be specially displayed at the World's Fair in Chicago, by the publisher, W. Engelmann of Leipzig.

THE COLORED PLATE of Opuntia prolifera in the January number of *Meehan's Monthly* is one of the handsomest that has yet appeared in that journal, and is accompanied by an unusually interesting description of the plant.

A BACTERIAL DISEASE of beans is figured and briefly described by Prof. B. D. Halsted in *Garden and Forest* for December (v. 620). It forms blotches upon the pods, and also attacks the leaves. Seed beans may be sufficiently affected to prevent their germination.

PUCCINIA AGROPYRI, a common American species of rust, has now been found in southern Europe by Dr. P. Dietel (*Hedwigia*, 1892), who has also found by culture experiments that it is genetically connected with Æcidium Clematidis, also common in America as well as in Europe.

BRADLEY M. DAVIS has filled up the gap in our knowledge of the life history of *Champia parvula* by tracing the development from the spore to a stage identical with the mature condition. Previous investigations by Debray and Bigelow have elucidated the structure of the adult frond.

DR. J. H. SANDBERG, of Minneapolis, invites the co-operation of botanists in the establishment of a botanical exchange bureau. The Botanical Division of the Department of Agriculture has decided, after consulting the members, to turn over to him the work of the Botanical Exchange Club.

M. HENRI HUA has begun in *Journal de Botanique* (Nov. 1) an enumeration of the Chinese species of *Polygonatum*, which represent half the known species. Recent explorations by M. l'abbé Delavay and MM. Farges, Soulié and Pratt, have brought to light 16 new species, making the enumeration for China reach 22.

J. CHRISTIAN BAY, a young Danish botanist now in the employ of the Missouri Botanical Garden, has been asked by the editors to review current literature of vegetable physiology for the Botanisches Centralblatt. The authors of papers dealing with vegetable physiology are requested to send copies to the library of the Garden, at St. Louis.

AT A RECENT MEETING (Nov. 3rd) of the Linnean Society, Mr. C. T. Druery exhibited some new examples of apospory in ferns, namely, a specimen of *Athyrium filix-fœmina*, var. *clarissima*, with pinnæ showing development of prothallia by soral apospory, and a seedling, *Lastræa pseudo-mas cristata*, showing prothallia developed aposporously over the general surface of the frond (pan-apospory).—*Gard. Chron.*

A NEW BOTANICAL JOURNAL was announced to appear in January under the title "Bulletin de l'Herbier Boissier," and will be published at Chambésy, near Geneva, under the direction of M. Eugène Autran, curator of the Boissier Herbarium. It will contain original papers, notes, etc., upon general systematic botany, and is promised to form yearly a stout octavo volume with plates. The price is 12 francs a year.

THE COMPILATION of the systematic and alphabetic index of new species of North American phanerogams and pteridophytes published in 1892, is now in preparation at the U. S. National Herbarium.

The index will be more nearly complete and published at an earlier date, if all botanists will promptly send to Dr. Vasey, Chief of the Botanical Division, their recent monographs and reprints of articles in botanical works.

IN A STUDY of regermination of seed Mr. A. M. Ten Eyck has found (*Agric. Science* VI, 454) that wheat will germinate fourteen times, after an interval each time of seven days drying at ordinary temperature. Corn gave six such germinations, radish five, parsnip and carrot two, and celery, clover and pansy one. It was also found that the seeds of any lot which germinated quickest were strongest and could withstand more drying. See also this journal, XVII, 230.

M. JULES CARDOT has begun in the fifth and sixth numbers (double) of the *Revue Bryologique* for 1892 a list of all the species of mosses now known from North America, showing their geographical distribution. The list is not critical, including all the species of Lesquereux & James' Manual and all new species described since its publication, except in the case of evident duplication. Enumerated in this way (useful at present, but obviously an overestimate) our bryologic flora contains about 1350 species.

THE BOTANICAL PAPERS read at the meeting of the Iowa Academy of Sciences, Dec. 27th and 28th, were: On the absence of ferns between Ft. Collins and Meeker, Col., by *F. M. Witter;* Phenological notes for 1892, Relation of frost to certain plants, Notes on the flora of Texas, and Pollination of cucurbits, by *L. H. Pammel;* Palisade cells and stomata of leaves, and A key for the identification of weed seeds in clover, by *F. C. Stewart;* and Notes on the flora of Muscatine, by *Fred. Reppert.* The Academy will hereafter have its proceedings published by the State.

A DESCRIPTION of last season's botanical work in Idaho, done by J. H. Sandberg, A. A. Heller and D. T. MacDougal, the party sent out under the auspices of the Botanical Division of the U. S. Department of Agriculture, appears in *Science* for Dec. 2, 1892, written by Mr. MacDougal. The north-central portions of Idaho were traversed, a region almost wholly unknown botanically heretofore. About 25,000 herbarium specimens, mostly phanerogams, embracing nearly a thousand species, were obtained, together with much valuable biological and geographical information pertaining to the vegetation of the region.

A NOTEWORTHY AND COMMENDABLE undertaking is that of a botanical survey of Nebraska, to be conducted by the Botanical Seminar of the State University. It is a private enterprise, to be paid for by the members of the Seminar, whose devotion in this respect cannot be too highly commended. Being private, the work can be purely scientific, and so of vastly greater interest to the botanical public. We look for results commensurate with the energy shown in the organization. A preliminary circular announcing the organization and its purpose has been issued, and from its tone it may be inferred that the work is not only to be prosecuted vigorously, but that the form of its publication will be as modern as the knowledge of the Seminar can make it. Mr. Albert F. Woods is the secretary.

THE LEAVES AND FLOWERS OF MILFOIL, or yarrow (*Achillea Millefolium*), inebriate, and were used by the Dalecarlians in Sweden to render their beer intoxicating. Clary (*Salvia Sclarea*) and saffron have also been used for this purpose. The last exhilarates the spirits to such a degree that, when taken in large doses, it occasions immoderate mirth and laughter. Darnel (*Lolium temulentum*), which is vulgarly known in England under the name of sturdy, when malted with barley, causes the ale brewed from it to be speedily intoxicating. Among the many different inebriants, the inspissated milky juice of the common garden lettuce is considered as powerful in its operation as opium itself.—LOUIS PIO in *Am. Brewer's Rev.* VI. 315.

BOTANICAL WORK is being prosecuted to a greater or less extent at thirty-two stations in the United States, as shown by statistics gathered by Prof. Atkinson and recently published in *Science*. The study of fungus and bacterial diseases and of their treatment is the subject receiving most consideration. Some give attention to systematic botany in the study of the native flora, a few are investigating the life history of certain fungi, and a few carry on physiological work. At some stations the botanist's duties do not materially differ from those usually performed by a horticulturist. On the whole the results of botanical efforts at the stations are commendable. They are certainly not behind the results displayed by the other departments of the stations.

MR. A. LASCHE CALLS ATTENTION (Am. Brewer's Rev. IV. 305) to the doubtful value of the results obtained by Dr. H. Moeller (Centr. f. Bak. u. Par. XII. 537) in the study of the spores of yeast. Dr. Moeller arrived at the conclusion that yeast has no true spores, that the so-called spores are without cell-wall or nucleus, and are incapable of germination. Mr. Lasché points out that the method used by the investigator would rarely result in spore formation, and that his photograms alone demonstrate that he obtained no true spores for study. Mr. Lasché's exceptions are certainly well taken, and it is strange how a lengthy, illustrated paper (14 pp., 1 pl.) with such sweeping generalizations, based upon such faulty observation, could find place in a high class journal.

A LABORATORY for the study of plant diseases has recently been fitted up in connection with the agricultural experiment station of the University of California, at Berkeley. A description of it with plans is given by Mr. C. W. Woodworth in a recent number of *Science* (XX 368), from which we learn that it consists of a room about twenty by thirty feet from which a corner is partitioned off for a private laboratory. There is also a small photographic dark room. The fittings consist of suitable tables, desks, shelves, etc., together with microscopes, microtomes and imbedding apparatus. Provision is made for cabinets of slides, herbarium specimens and pathological samples. The subject is approached from the entomological side, which probably accounts for the fact that while an improved insect box is described nothing is said of apparatus for the cultivation of fungi and bacteria.

PROFESSOR CARRUTHERS' report of the Department of Botany of the British Museum for 1891, appears in the *Journal of Botany* for December (1892). During the year 41,875 specimens have been placed in the herbarium, most of them being collections of oriental plants. It is

reported that the DeBary slides have been arranged in systematic order. "The medium originally employed in mounting the preparations having been insufficiently secured, every slide has been carefully examined, resealed, and, wherever necessary, the specimen has been remounted." The William Smith typical collection of British *Diatomaceæ*, illustrating his standard work, has been added to by the mounting of much unmounted material. Triana's study set of New Grenada plants, which has formed the basis of his publications, is one of the notable additions of the year, as is also the Ravenel collection of N. Am. cryptogams, consisting of more than 14,550 specimens, and including all the species which were described from his material by Berkeley and others.

THE FIRST FASCICLE of "Grasses and Grass-like Plants" issued by A. B. Seymour, of Harvard University, is the beginning of what promises to be a valuable aid to workers among such plants. The fascicle issued contains rushes and sedges, as well as true grasses, and illustrates a wide range of genera as well as of localities, and of the more variable species two or more specimens are given showing extreme as well as typical forms. Each specimen has been compared with others of the same species in the Gray herbarium, or has been determined by some recognized authority whose name appears on the accompanying label. The labels also give references to various government and station publications regarding the economic importance of the species. The specimens are of standard size, and usually well preserved.

The want of authentic specimens for comparison has been deeply felt by all agrostologists, especially by those who are connected with the experiment stations, and we are glad to know that Mr. Seymour intends to continue his distributions until all the more important species have been illustrated.—S. M. T.

THE BOTANICAL PAPERS presented at the eighth annual meeting (Dec. 28th and 29th) of the Indiana Academy of Science are as follows: Notes on the reproduction and development of Grinnellia Americana Harv., *M. A. Brannon;* Some effects of mutilation on forms of leaf and sex of Morus alba and M. nigra, *A. N. Somers;* Botanical field work in W. Idaho, and How a tendril coils, *D. T. MacDougal;* The application of mathematics in botany, and An auxanometer for the registration of growth of stems in thickness, *Katharine E. Golden;* On the fertilization and development of the embryo in Senecio aureus, and The apical growth of the thallus of Fucus vesiculosus, *D. M. Mottier;* Distribution of the N. Am. Cactaceæ, *John M. Coulter;* Marchantia polymorpha not a typical or representative liverwort, A state biological survey, and The need of a large library of references in cryptogamic botany in Indiana, *L. M. Underwood;* Forestry exhibit of Indiana at the Columbian exposition, Notes on the flora of the Chilhowee and Great Smoky Mts., and Additional facts regarding forest distribution in Indiana, *Stanley Coulter;* Notes concerning certain plants of the S. W. counties of Ind., and The "Lilly Herbarium" and its work, *John S. Wright;* Spines and epidermis of cactaceæ, *E. B. Uline;* Preliminary notes on the genus Cactus, *E. M. Fisher;* Some causes acting physiologically toward the destruction of trees in cities, and Botanical assemblies in the U. S. announced for 1893, *J. C. Ar-*

thur; Symbiosis in Orchidaceæ, and The genus Corallorhiza, *M. B. Thomas;* Development of ovule in Aster and Solidago, *G. W. Martin;* Notes on root tubercles of indigenous and exotic legumes in virgin soil of the northwest, *H. L. Bolley.*

IN THE *Kew Bulletin* for December there is a very interesting paper upon the disappearance of desert plants in Egypt. It relates to the causes of the disappearance of the arboreal desert vegetation of Egypt within historic times, being an extract from the report of the expedition despatched by the Khedive in 1891 to the country between the Nile and the Red Sea. Conclusive evidence is first advanced of the former abundance of an arboreal desert vegetation in comparatively recent times, and the cause of its disappearance is summed up as follows: "To sum up all the facts which I have urged in the preceding pages, it seems clear that in the camel, nature has created a Frankenstein which in this country is gradually devouring her. And it seems that what is applicable to this country is applicable to all countries where soil and climate are fit to produce wild shrubs but not fit to support cultivation. It seems that nature is being slowly but surely beaten by the camel and his inevitable but improvident companion, the axe. Nature fights hard. This year copious rains have fallen in the mountains, but the reply of the Arab is to send for grazing a correspondingly larger number of camels." The same case is called on to explain the disappearance of frankincense and spices from S. Arabia, and of the former abundant vegetation of Palestine which could support a population and herds out of all proportion to its present circumstances. In fact the Arabs in Palestine say that there were formerly lions there, but they were frightened away by the camel. "It is probable that the camel has expelled the lion from Palestine, not by roaring, but by consuming the shrubs which supported the lion's prey."

FROM advance sheets of the fourth annual report of the Director of the Missouri Botanical Garden we gather the following:

The number of visitors to the grounds through the past year has been considerably increased as compared with preceding years.

A marked improvemen has been made this year in opening up the eastern side of the garden proper, which has been densely shaded heretofore by overgrown shrubbery. This has permitted the conversion of a large tract of bare ground into lawn. The decorative plants, which have been increased considerably in number notwithstanding this seeming extension of the lawn area, have been grouped in clusters instead of being arranged as heretofore in long monotonous rows of a single species, and the number of species in cultivation has been greatly increased by gifts and purchases, and the Director was able to secure from the dry district of Texas, Arizona and California a number of representatives of the more characteristic yuccas, agaves and cacti.

The chief additions to the herbarium have consisted of the current American collections, about 3,000 duplicates from the herbarium of the late John Ball, and a set of some 1,200 New Zealand plants, purchased; and a set of the valuable Exsiccatæ of the Austrian flora, donated by the Vienna Museum. The herbarium, as now arranged, is composed of about 16,000 specimens of thallophytes and 187,000 of other plants.

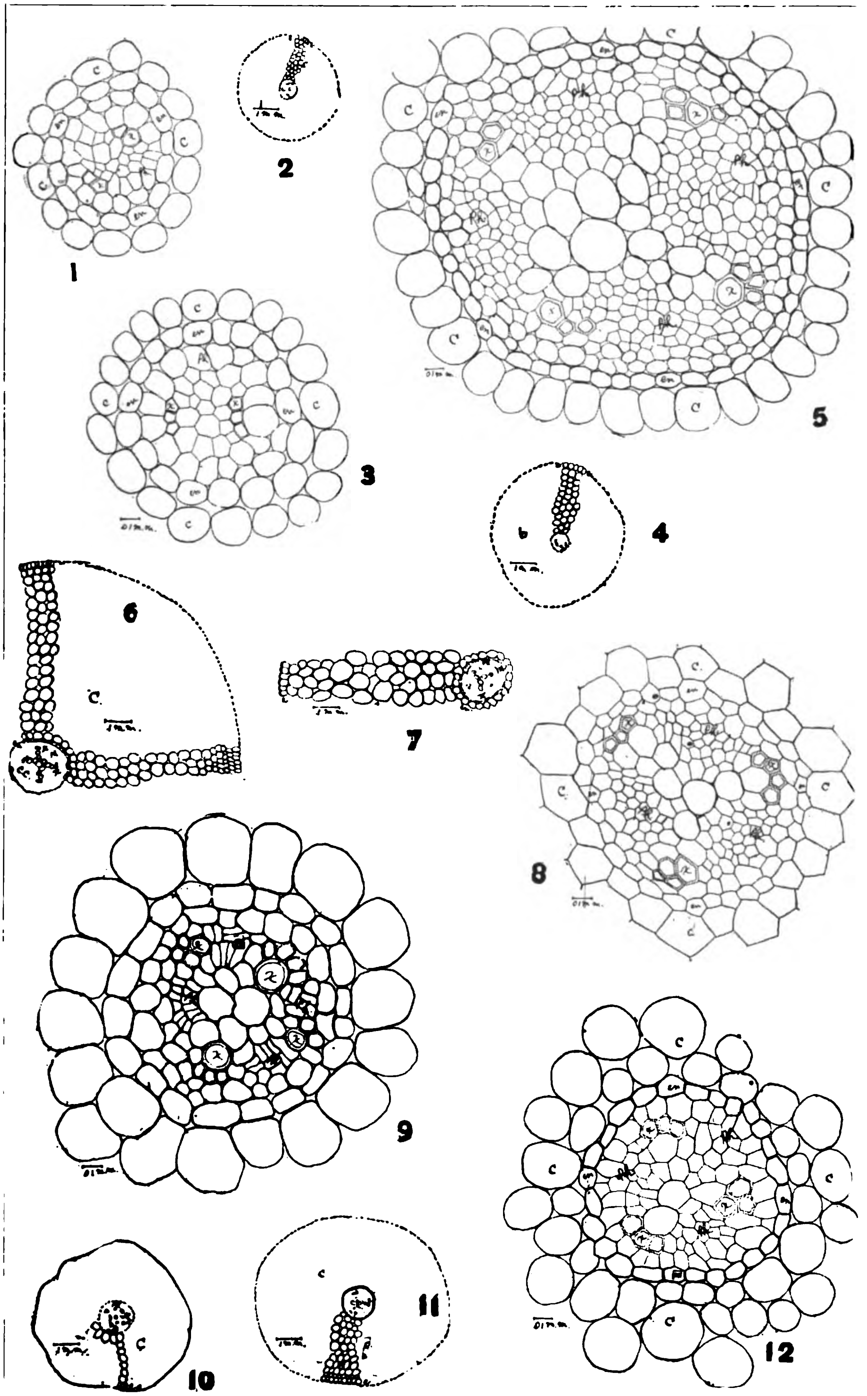
It has not been found practicable to add to the library as freely as could have been wished, but during the year about $1,427 was spent for purchases and binding. A much needed card index to the species of plants described and figured in works at the Garden has been begun.

An enumeration of the present contents of the library shows 5,225 books, appraised at $19,300, 6,280 pamphlets, appraised at $1,850; giving a total valuation of $21,150.

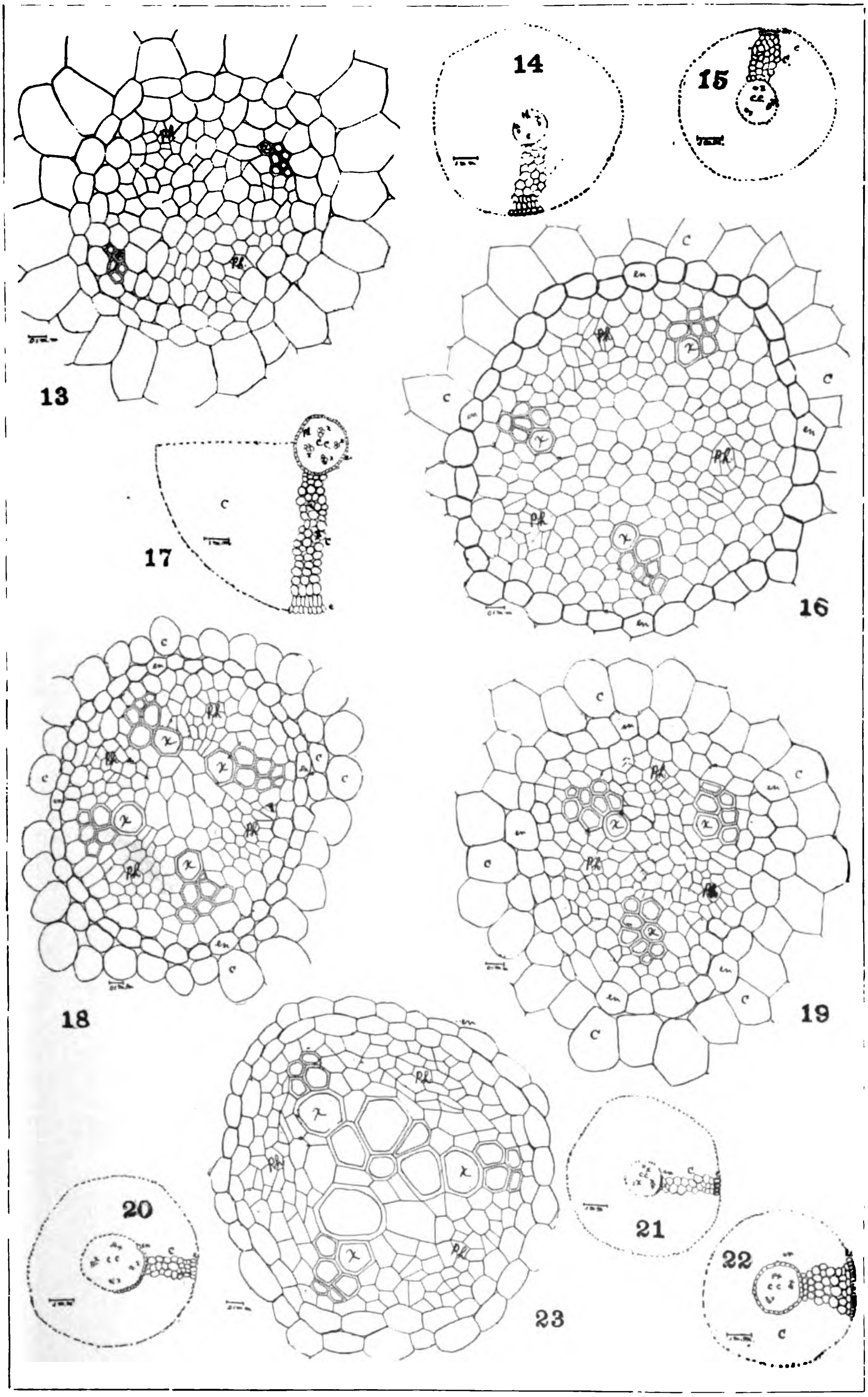
Dr. Sturtevant has donated his entire botanical library, including the scrap books of his own writings and his manuscript notes on edible plants, with the privilege of retaining the books during his life, or so long as he may have occasion to use them. The library presented in this manner by Dr. Sturtevant is undoubtedly the most complete and valuable American collection of pre-Linnæan botanical books, and represents the expenditure of a great amount of time and money on his part, since he has for many years been interested in bringing together the early literature of the science, especially in its application to economic plants. In accepting this generous and quite unsolicited gift, the Board of Trustees of the Garden at their November meeting expressed their appreciation of its value and of the spirit in which it was tendered, and voted that on its actual receipt at the Garden it should be arranged, together with other works published prior to the time of Linnæus, in a separate alcove, the whole to be known as the E. Lewis Sturtevant library of pre-Linnæan botany. Whenever this alcove shall be opened, a catalog·e of its contents will be published, in order that students of botany may know where a collection of books of this character can be consulted.

In the early part of the year, Dr. Sturtevant also donated to the Garden his extensive and valuable collection of specimens, manuscript and illustrations, largely in color, of the genus *Capsicum*, on condition that the genus should be studied with reference to an ultimate monograph of the wild and cultivated forms. On accepting this generous gift, seeds were procured of all obtainable varieties, and about 125 named sorts have been cultivated by Mr. Duffey, and made the subject of study through the season by Mr. Dewart; and it is proposed to continue the work through 1893 and as much longer as may be necessary.

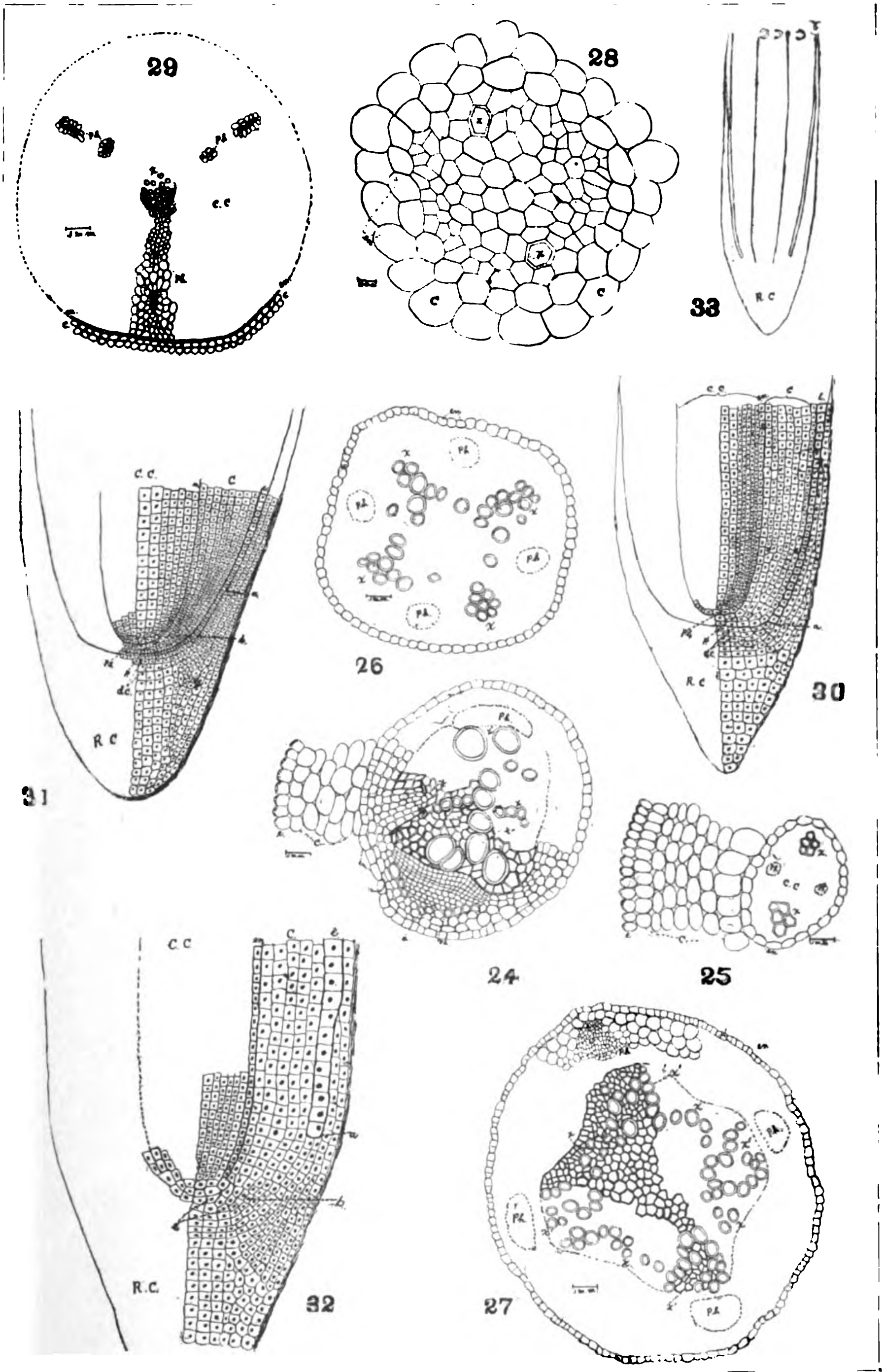
In order to obtain facilities not in its possession for the study of marine botany, and with a view to promoting such study, the Board this year authorized the Director to subscribe for the present $100 annually, for a botanical research room in the Marine Biological Laboratory at Wood's Holl, Mass., on condition that it should be actually used each year for botanical work. It is not probable that a member of the Garden staff can regularly make use of the facilities secured in this way, and when this cannot be done the Director is desirous of having the room used by some competent botanist not connected with the Garden, and invites correspondence early in each year from professors or others who may wish to study our marine flora. The only conditions imposed in such allotment of the room are that it shall be used exclusively for botanical work, and that in the publication of any results obtained the Garden shall receive credit for the facilities offered; but the Director wishes, if good reason to the contrary does not exist, to have the results of any important research published in the reports of the Garden. During the season of 1892, the room was used by Mr. M. A. Brannon, who was occupied with a study of *Grinnellia Americana.*



MAXWELL on ROOTS OF RANUNCULACEÆ.



MAXWELL on ROOTS OF RANUNCULACEÆ.

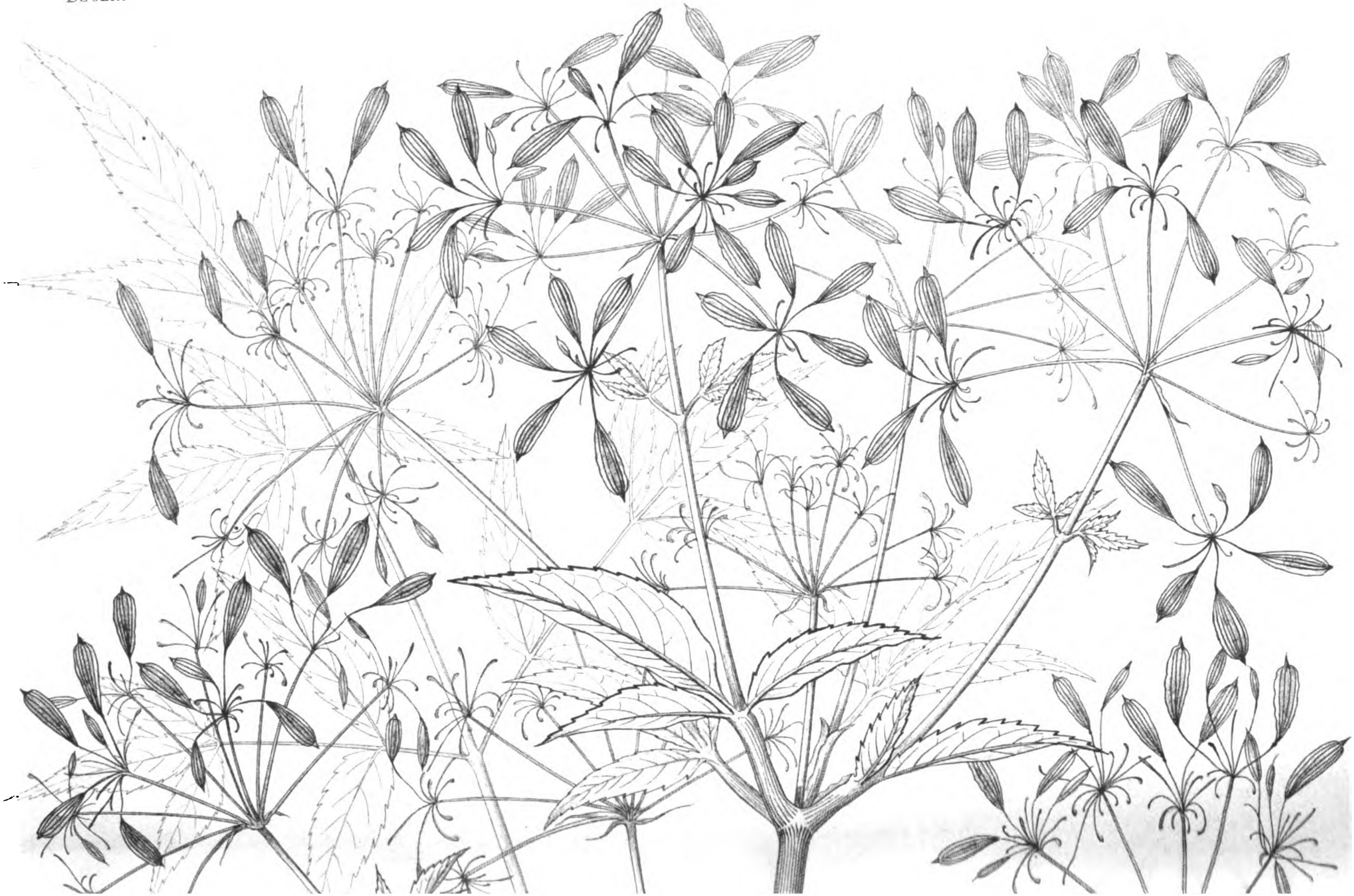


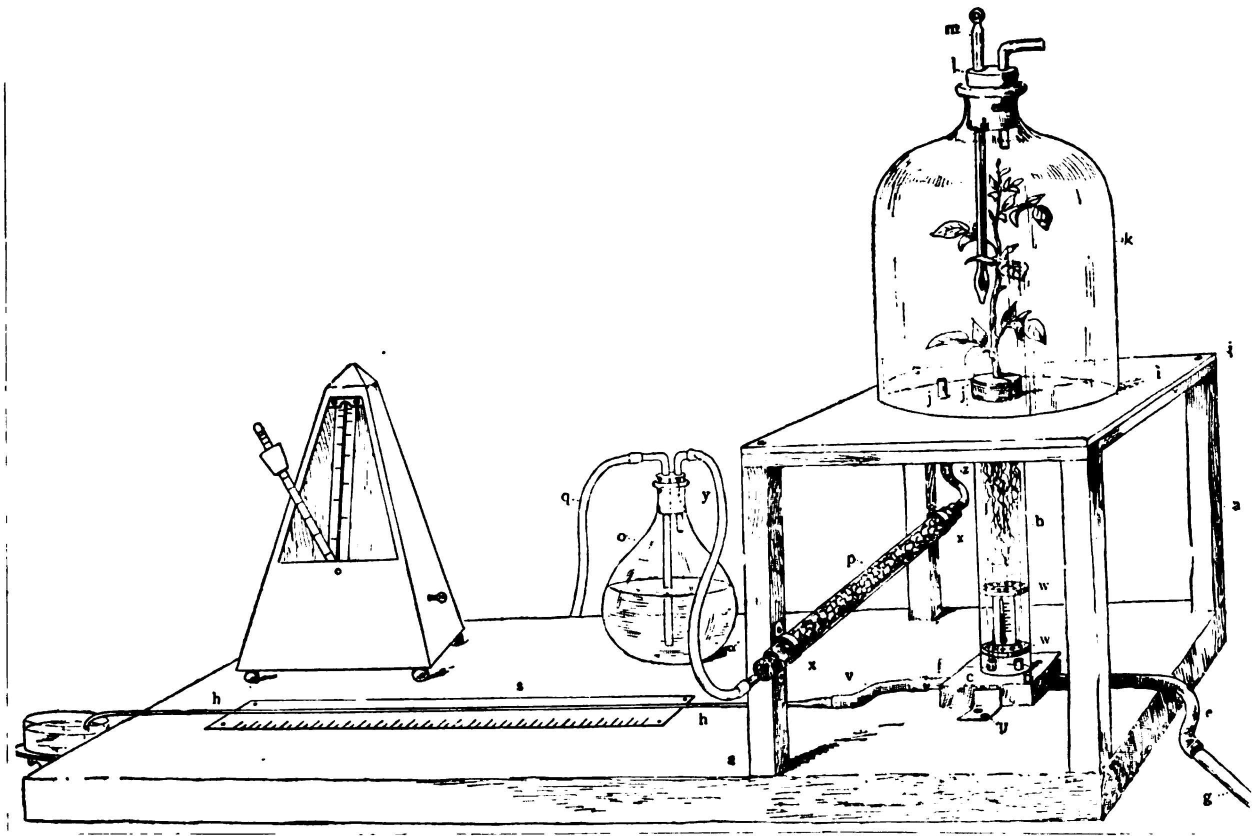
MAXWELL on ROOTS OF RANUNCULACEÆ.

C. E. Faxon, del.

B. Meisel, Lith Boston.

ENANTIOPHYLLA HEYDEANA Coulter & Rose.





SCHNEIDER on TRANSPIRATION.

Botanical Gazette

MARCH, 1893.

On Monilia fructigena.

JAMES ELLIS HUMPHREY.

WITH PLATE VII.

During the past fifteen years or more, attention has several times been directed, especially by American writers, to a parasitic fungus which causes great destruction of the fruits of certain cultivated *Rosaceæ*, chiefly *Pruneæ* and *Pomeæ*. It is most common on the stone-fruits, so that the affection to which it gives rise is ordinarily known in America as the "brown rot of stone-fruits." This fungus has been called by most recent writers *Monilia fructigena* Pers., but was earlier known as *Torula fructigena* Pers., *Acrosporium fructigena* Pers., *Oidium fructigenum* Lk., *Oidium laxum* Ehr., *Oidium Wallrothii* Thüm., and *Oospora fructigena* Wallr. It appears to have been first named *Torula fructigena* by Persoon[1], and was subsequently transferred by him[2] to the genus *Monilia*.

The plant was for a long time regarded as a saprophyte and von Thümen[3] and Hallier[4] seem to have been the first to point out its economic importance. Thümen subsequently[5] discussed its effects more fully, bringing out more prominently the evidence for its truly parasitic nature, and its claims to be regarded as a disease-producing organism. Yet the chief handbooks of plant diseases pass it with very brief mention or with none, and, even at present, it does not appear to be recognized in Europe as a source of loss to the extent that is fully justified by its ravages in America. Here it was first described by Peck,[6] in 1881, and by Arthur,[7] in 1884.

[1] Observ. Mycol., 1: 1796.
[2] Syn. method. Fung., p. 693: 1801.
[3] Oesterr. landw. Wochenbl., 1875, n. 41, p. 484.
[4] Wiener Obst- u. Garten-Zeitung, 1876, p. 117.
[5] Fungi Pomicoli, p. 22: 1879.
[6] 34th Rep't N. Y. State Museum, p. 35. See also 43rd Rep't do. p. 6.
[7] 4th Rep't N. Y. Agr. Exp. Sta., p. 254.

Subsequently its structure, as well as its disease-producing capacity and its means of dissemination and survival, have been studied by Galloway,[8] Smith[9] and the writer.[10] Various other accounts of its attacks, with recommendations as to the best means of avoiding them, have been published, chiefly in experiment station literature, and need not be more precisely quoted here. Neither need the results of studies bearing on the prevention or avoidance of the ravages of this fungus be discussed, since our present concern is with its structural relations.

The fungus, which, as Galloway[11] and Smith[12] have shown may attack foliage and young branches, as well as fruits, appears externally in the form of ashy tufts. Each tuft consists of a very large number of threads breaking through a common rift in the surface, and extending to a short distance in either direction from this center. These threads are much branched and consist of chains of ovate or oval thin-walled bodies, strung together in moniliform rows, which may be termed, in a general sense, spores (fig. 1).

The spores are formed, not by successive basipetal constrictions of a hypha, which has previously reached a determinate length, but by repeated budding in basifugal succession, so that the terminal joint or spore is the newest. Occasionally a joint may broaden at its end so that it has two apical angles, and may then produce a bud from each of these angles (fig. 2), thus giving rise to the dichotomous branching of the thread. It is in this way that the branches always originate. After the formation of a thread of greater or less length, according to circumstances, the separate joints or spores mature, and then separate from each other very readily. Thus, while the growth of the threads is indeterminate, their length does not become great in nature, apparently because the influence of the weather is to hasten their breaking up. But in a moist chamber, where these disintegrating forces are less active and the conditions favor very rapid growth, they may become extremely long.

The internal mycelium of the fungus consists of septate cylindrical hyphae, which ramify through the tissues of the

[8] Rep't U. S. Dep't Agr., 1888, p. 349.
[9] Journ. Mycol. v, 123, and VII, 36. 1890 and 1892.
[10] 8th Rep't Mass. Agr. Exp. Sta., p. 213: 1891.
[11] Loc. cit.
[12] Loc. cit.

host, and, breaking finally through its surface in fascicles, pass directly into the external spore-threads.

The mature spores germinate readily under the influence of warmth and moisture, and produce short threads which ordinarily perish after a few days in water that contains no available nourishment beyond that stored up in the spore. In a natural or artificial nutrient substratum the germ-tubes grow rapidly, penetrating and ramifying through the substratum and soon breaking out through its surface in tufts of spore-threads. Since the spores germinate so readily and are so thin-walled, it has been assumed that their vitality is of brief duration and that they constitute a so-called conidial stage of some fungus, perhaps one of the *Ascomycetes*. Woronin has suggested[13] that it may bear such a relation to some *Sclerotinia*. In the absence of knowledge of its affinities it has been classed among the imperfect fungi, being placed by Saccardo[14] in his *Mucedineae amerosporae*.

Smith has lately observed[15] that the spores retain their vitality, at least in some cases, for a long time; and both he and the present writer[16] have found that the dried tissues of fruits spoiled by the fungus contain a resting mycelium (fig. 3), and even definite thick-walled resting bodies or *gemmae* (fig. 4), probably developed from the mycelium. These resist long periods of unfavorable conditions and promptly give rise to new spore chains on the return of conditions favorable to vegetation. Thus, when a fruit that has been "mummified" by the fungus is gathered in winter or early spring, it commonly sends out new spore-chains of the *Monilia* type, on being placed in the moist chamber. And the same thing occurs spontaneously in nature when the weather becomes warm and damp enough, later in spring. These facts do away with a necessity for any other stage in the history of the plant and make it possible to believe in the autonomy of the form under discussion.

This, in brief, is the present status of our knowledge of the fungus. It is the object of this paper to describe and discuss the significance of certain previously undescribed structures

[13] Mém. Acad. Sci. St. Petersburg, VII. xxxvi, no. 6: 1888.
[14] Sylloge Fungorum, iv, 34.
[15] Journ. Mycol. vii, 36; 1892.
[16] Loc. cit.

that have been met with in the course of a series of cultures of the form. When a mummied fruit is placed in the moist chamber, it not infrequently happens that it fails to produce spore-chains, and to the unaided eye gives little evidence of any change. This occurs especially in late fall, soon after the cessation of vegetative activity. But if the surface of such a fruit be examined microscopically, it will usually be found that the mycelium of the fungus has given rise to immense numbers of closely-set, flask-shaped sterigmata, reminding one of those of *Aspergillus*. Each of these produces at its outer or neck end small globular spores of about 3μ in diameter, every one of which contains a conspicuous oil globule. One rarely finds more than one of these attached to the sterigma, but their vast number and the occasional observation of several still united shows that they must be produced in chains, like *Aspergillus* spores.

When some of these spores are sown on nutrient gelatine they germinate readily, first swelling to double their former diameter, and produce abundant mycelia (fig. 8). After a few days hyphae emerge from the surface of the gelatine and develop typical *Monilia* chains, thus demonstrating the specific identity of the two spore-forms. It is noticeable that these much condensed globular spores increase largely in volume on taking up nourishment, while the *Monilia* spores, originally much larger, undergo no increase in size.

A culture made in the fall of 1890, on prune-gelatine, with *Monilia* spores, at first produced the usual spore-chains and continued to grow until the nourishment contained in the small drop of gelatine was exhausted. At the end of a month from the beginning of the culture, during the whole of which the atmosphere of the moist chamber had been hardly at all disturbed, it was found that some of the chains remained still quite long, while some had broken up spontaneously into their constituent joints. Numerous separate spores lay about upon the surface of the shrunken and exhausted gelatine film or upon the supporting glass slide. Both of these surfaces were only slightly moist, but a number of spores were found to be germinating upon them. That they were the *Monilia* spores cannot be doubted, since they agreed completely in all respects with those still in chains near by. But under the conditions presented, of moderate moisture, lack of nourishment, and perhaps others not recognized as important, their

germination was quite different from the usual form. Each spore gave rise, from any part of its surface, to a single germ-tube, or very rarely to two, which became cut up by a few transverse septa. In most cases one or more of the basal cells remained sterile, while some or all of the others produced one or two flask-shaped outgrowths each. At the top of the neck of the flask were formed, in each case, globular spores, 2.5 to 3μ in diameter, of which not more than one was ever seen attached (fig. 6). These spores were also found fallen from their attachments and beginning to germinate (fig. 6, *a*). In other words, these germ threads from the *Monilia* spores produced precisely similar structures to those which we have seen to be sometimes produced by the resting mycelium at the surface of the natural substratum. While these spores can germinate without nourishment, they suffer no preliminary increase in size. On prune-gelatine they swell and germinate as above described. Though their development could not be followed through, there is no reason to doubt that it agrees with that already outlined for this spore-form.

On another occasion, a stout hypha in a culture on prune-gelatine was observed to produce, at the ends of short branches and on slight outgrowths from its sides, long chains of similar globular spores. In this case the spore-chains, having been quite undisturbed, could be plainly recognized, though they readily fell into short sections or into their component spheres (fig. 7). In spite of the absence of distinct sterigmata, it seems probable that this is essentially the same form as the previously described one, since the spores are produced in the same way, are of about the same size, and contain the characteristic oil-globules.

When *Monilia* spores are sown directly upon the surface of nutrient gelatine, they quickly develop a mycelium and spore-chains, as has been said. Several times I have observed, in cases where some spores had been sown a short distance beyond the edge of the gelatine drop, that the threads from them, growing slowly toward the drop, when they finally reached it began, as was to be expected, to grow much more rapidly. But, instead of remaining naked threads, they produced, by a sort of budding from various points or from nearly all points along their sides, oblong bodies, as shown in fig. 5. Sometimes these bodies were far more abundantly produced than is shown in the figure, so that they almost

completely filled the gelatine over considerable areas. Unfortunately, their future fate and their capacity for germination were not determined; but that they belong to the *Monilia* cannot be doubted, since the threads which gave rise to them were seen to originate from *Monilia* spores in pure culture and the same threads were traced through the gelatine to points where they emerged from the surface and became *Monilia* chains.

In examining the significance of the phenomena described, we are led first to ask how the various structures described are to be regarded. It is evident that the spores of the *Monilia* chain are not conidia in the truly morphological sense in which Brefeld uses[17] the term. That is, they are not spores produced in fructificative fashion on specialized spore-bearing threads. They are simply slightly individualized portions of mycelium with the form and physiological characteristics of spores. Though differing in the details of their development from the spore-chains of the *Erysipheæ* which constitute the old genus *Oidium*, they are morphologically similar to them. And indeed, as above noted, some writers have included the present plant under that generic name. As Brefeld has shown, all these "Oidien-ketten" are to be regarded as the simplest type of chlamydospore formation. A consistent terminology will, then, designate the common spores of *Monilia fructigena* as chlamydospores of the most primitive type, for which we may retain the name *Oidium*. But the name must be understood in a morphological and not in a systematic sense.

In view of the incompleteness of our knowledge of the oblong bodies described last and shown in fig. 5, it seems best merely to record their occurrence and to await fuller information as to their early and subsequent history, before attempting any discussion of their significance. While it seems probable that they have reproductive capacity, there is little evidence on this point either from their own development or from analogy, since one hesitates to homologize them fully with other described organs of fungi.

On the other hand, the spores of the second form above described are produced on distinct, if short, sporophores and

[17]Unters. aus dem Gesammtgeb. d. Mykol., 7, 244. This clearly marked and fundamentally important distinction between the conidium and the chlamydospore must be generally recognized.

constitute a true fructification. They are, in any point of view, to be called conidia. Furthermore, the homologies of this form seem to be clear. Tulasne[18] has figured similar structures which he observed on the mycelia of *Peziza* (*Sclerotinia*) *tuberosa* and of the closely related *P. bolaris* and *Durieuana*. Brefeld[19] has found them in his cultures of *Sclerotinia tuberosa* and *Libertiana*, and DeBary[20] has seen them in the latter species and *Scl. Fuckeliana*. Zopf[21] saw very similar structures on the mycelium of *Chaetomium*, and Woronin[22] in *Sordaria*. In all of these cases the general structure and mode of development of these conidia is the same. Tulasne found them rather sparingly produced on young germ-tubes developed without extraneous nourishment, just as did the writer in one instance. Brefeld and DeBary obtained them very abundantly in cultures on nutrient media, which was once the writer's experience. When developed from a resting mycelium, they are produced almost as abundantly as on nutrient media. Neither of the writers mentioned above was able to observe the germination of these spores, and they were classed by DeBary[23] as "doubtful spermatia," under the influence of his well known views concerning the typically sexual character of the *Ascomycetes*. It is certain, however, that the conidia associated with *Monilia fructigena* germinate readily and produce a mycelium and *Monilia* chains, as above described. This fact makes it probable that the corresponding forms associated with other fungi, especially with *Sclerotinia* species, are also to be regarded both morphologically and physiologically as microconidial stages, although the conditions of their further development still remain unknown.

In his study of the several species of *Sclerotinia* which attack the leaves and fruits of European *Vaccinium* species, Woronin[24] found a chlamydosporic stage of *Scl. Vaccinii* that very closely resembles that long known as *Monilia* or *Torula fructigena*. His form is in some respects more highly differentiated than the latter, especially in its development of

[18]Selecta Fungorum Carpologia, III, t. 22: 1865.
[19]Bot. Unters. über Schimmelpilze, IV. 113; t. 10: 1881.
[20]Comp. Morph. and Biol. Fungi: 1884; Eng. trans., 243.
[21]Nova Acta A. C. L.-C. N. C. XLII, no. 5: 1881. Also, Die Pilze, 453: 1890.
[22]Beitr. z. Morph. u. Phys. d. Pilze, III: 1870.
[23]Loc. cit.
[24]Ber. d. D. Bot. Gesell., III, p. lix: 1885. Also, Mém. Acad. Sci. St. Petersburg, VII. XXXVI, no. 6: 1888.

cellulose plugs between the spores, which by their growth force the spores apart and so serve to disseminate them. This plug, called by Woronin the disjunctor, is not in any way represented in *M. fructigena.* Yet the whole habit of growth and the general mode of spore-formation is so similar in the two forms as amply to justify Woronin's suggestion of their possible near relationship. The probability of the correctness of this idea is still further increased by the observation of the microconidial stage above described, although none such is mentioned by Woronin as belonging to either species of the group of *Sclerotinia Vaccinii.* For the occurrence of such a stage in the commonest and best known species of *Sclerotinia* with conidia of the *Botrytis* type[25] affords ground for the belief that another species possessing it may be a *Sclerotinia,* also; and the combined evidence of the microconidial and chlamydosporic stages is very strong. Assuming for the moment that the forms above described are imperfect stages of a *Sclerotinia,* the microconidial form connects the two groups of the genus in an interesting way, bringing more closely together those possessing macroconidia of the *Botrytis* type and those whose "summer-spore" stage is a chlamydosporic one of the *Monilia* type.

As to the actual existence of a perfect form of *Sclerotinia* to which our *M. fructigena* belongs, it can only be said that in the examination of a very large number of fruits in all stages of disease from the attacks of *Monilia,* at all seasons, the writer has never seen any trace of sclerotia or spore-cups; nor have any such been mentioned by other writers. It seems, therefore, pretty certain, in view of the attention that the fungus has received in recent years, that the development of such structures is exceedingly rare, at least. As has been pointed out above, the fungus commonly perpetuates itself by means of its resting mycelium, and the development of sclerotia is therefore wholly unnecessary to the preservation of the species. One may therefore be quite justified in the belief that in *Monilia fructigena* we have the persistent chlamydosporic and microconidial stages of a *Sclerotinia,* allied to *S. Vaccinii,* whose perfect stage has become practically or entirely suppressed.

[25] I shall show in the forthcoming report of the Massachusetts Agricultural Experiment Station that it is probable that *Scl. Libertiana* possesses such a conidial form.

I have not been able to examine the large number of forms included by Saccardo under *Monilia*. Of these it is probable that many have no real affinity with that above discussed; while others may be closely related. Such appears to be the case with a rather common form which attacks the immature fruits of *Prunus serotina* and related species, forming delicate white tufts, with spores very like, but somewhat smaller than those of *M. fructigena*. This is probably the plant called by Saccardo[26] *Monilia Peckiana*, var. *angustior*. The few cultures I have been able to make have yielded only the common spore-chains, but the form will probably repay further investigation as to its pleomorphism and its affinities.

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EXPLANATION OF PLATE VII.

Fig. 1. Two *Monilia* hyphæ passing into branching spore-chains. ×540.

Fig. 2. The end of a spore-chain, showing the origin of branching from two terminal angles of the terminal cell. ×540.

Fig. 3. Bits of resting mycelium from the flesh of a "mummied" plum. ×540.

Fig. 4. Resting cells, "*gemmae*," from the same source. ×540.

Fig. 5. Hyphæ from *Monilia* spores, with oblong bodies developed within the gelatine. *a*, ×540. *b*, ×940.

Fig. 6. Three *Monilia* spores producing germ-tubes with sterigmata and microconidia. *a*, germinating conidia. ×940.

Fig. 7. Chains of microconidia from *Monilia* hypha, in culture. ×540.

Fig. 8. Microconidia germinating on nutrient gelatine. *b*, after one day, ×940. *a*, after 2 days, ×540.

Non-parasitic bacteria in vegetable tissue.[1]

H. L. RUSSELL.

It has been ascertained that the tissues of the animal body in their normal healthy state are perfectly free from bacteria but the evidence that the same is true in regard to vegetable life is not so unanimous. The subject has received considerable attention at the hands of bacteriologists and while the majority of observers do not admit that bacteria are to be found in vegetable tissue in a healthy state, some proof has been brought forward to support such a conclusion[1].

In a course of experiments, which have been carried on for

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[26]Sylloge Fungorum, IV, 34.

[1]Read at the Rochester meeting of the A. A. A. S., August, 1892.

some time in another connection, I have noted a number of points that seem to have a direct bearing on this question and afford a possible explanation for the contradictory evidence previously at hand.

The effect of the inoculation of various saprophytic as well as facultative parasitic species of bacteria into the tissue of different plants was studied in order to determine first, the effect produced on the plant, if any, and second, the reciprocal effect on the micro-organism.

Caulescent plants,[2] such as Geranium, were selected and into these were injected various forms of micro-organisms, after washing the stem with sterile water to rid it as far as possible of the bacteria on its surface. The minute opening in the stem caused by the inoculating needle was closed by sterile vaseline, so as to prevent the entrance of foreign organisms. In this way different species of bacteria were introduced into the interior of rapidly growing healthy plants, and after varying periods of incubation, their effect was ascertained. With certain saprophytic forms such as B. megaterium, B. lactis aërogenes, B. butyricus, etc., as well as those species pathogenic for animals like B. anthracis, B. typhosus, B. diphtheriae columbarum, no macroscopic change could be detected in the tissue of the host when it was in a healthy growing condition. Of course those forms that are pathogenic for plants, such as pear blight, did affect their respective hosts when inoculated into susceptible plants, but when species not closely related to their normal hosts were used, no macroscopical change could be noticed in the condition of the plant. A microscopical examination of the tissues also failed to reveal any pathological conditions brought about by the injection of the micro-organisms.

So much for the effect of the micro-organism on the plant.

The effect of the host upon the micro-organism was, however, greatly different. This was determined by means of culture experiments. The plant tissue into which the bacteria had been injected was taken after varying periods of incubation and the cortical ring of tissue removed by sterile scalpels, after which quite thin transverse sections of the remaining core of tissue were sectioned, also under aseptic precautions. These were then seeded in melted gelatine tubes

[2]Fazio: Revista Intern. d'Igiene (1890); Galippe, and others.

and roll cultures made therefrom. The liquefied gelatine penetrates the section and the bacteria present are able to grow. Not only were cultures made in this way from the tissue taken at the point of inoculation but sections were also taken at varying intervals both above and below the point of introduction. Special care was taken in the use of germ-free instruments, so that there was no possibility of transferring bacteria from one section to another.

The results obtained in this way were quite various. Nearly all of the species pathogenic for the animal body, as B. anthracis, B. diphtheriae, B. cholerae gallinarum, Micrococcus tetragenus, M. cereus flavus, Staphylococcus epidermis albus and St. pyogenes aureus, were killed out in the plant tissues after a lapse of a few days. One notable exception was, however, observed in the case of B. pyocyaneus. This germ was able to live in healthy plants of different species like Geranium, Penthorum and Begonia for 50 to 70 days or more and even able to spread throughout the plant tissue in an upward direction to a distance of 50 to 80^{mm}. By far the greater number of the parasitic bacteria, however, were unable to survive in the plant.

With saprophytic bacteria, the case was usually different. B. prodigiosus, B. butyricus, B. luteus, B. coli communis, B. fluorescens, and the lactic acid germ were all to be found in large numbers after varying periods of incubation ranging from 20 to 50 days, not only at the point of inoculation but in gradually lessening numbers for some distance up the stem.

Other species like B. megaterium and B. lactis aërogenes were to be detected in the tissue after 40 days but only in small numbers and *only* at point of inoculation.

Now these results indicate that bacteria, saprophytes at least, can live in the tissue of plants for a considerable length of time, and the fact that they are able not only to exist at the point of introduction but to spread throughout the tissue to a limited extent raises the question as to whether they are not really able to grow, to a limited extent at least, if they once gain access to the less resistent tissues of the inside of the plant.

On this point, enough data have not yet been gathered to say definitely, but these observations are presented with ref-

erence to the first question raised, as to the presence of bacteria in normal healthy tissues.

It has been shown that certain bacteria *can* live in plant tissues for a long time, if they are once allowed an entrance (as by artificial inoculation). What happens by artificial inoculation can under certain circumstances also take place in a state of nature. If by any means, a plant is wounded in any way, bacteria can enter from the air, and if the tissues are succulent enough, they can at least live for considerable time. Bacteria introduced in this way as wound parasites would come to be enclosed in the tissue by the healing over of the wounded surface, and thus error might arise as to their origin even if the experiments were carried out on the most rigid of bacteriological principles. A minute puncture would suffice to allow them to enter, as was to be seen when a sterile platinum needle was thrust into the tissue of a stem and then the wound closed by vaseline as before. Cultures from the pith parenchyma showed bacteria that were also to be found on the epidermis of the plant.

In connection with the above results, I have made numerous attempts to isolate micro-organisms from different forms of vegetable tissue, where I first made sure that there were no wounds, but in no case have I been able to isolate them where the conditions of the experiments were faultless. The appearance of a single colony or so in the cultures occasionally, is due to the inevitable exposure at the time of preparation of cultures. The danger of external contamination is much less where stems of fairly good size are used instead of such subterranean organs as rhizomes. Bacteria are present in the superficial soil layers in myriads and it is easy to see that by some slight abrasion or puncture of the epidermis they can gain access to the inner tissues of the plant and here live for a considerable length of time.

The evident conclusion from these results is that vegetable like animal tissue is normally free from micro-organisms, but that in healthy plant tissue many species of bacteria are able to exist for a not inconsiderable length of time. This is true with the most healthy growing plants, and where the vitality of the plant is weakened to any great extent, the micro-organism is much more able to sustain itself in the struggle for existence.

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A comparative study of the roots of Ranunculaceæ.

FRED. B. MAXWELL.

WITH PLATES II—IV.

(Continued from p. 47.)

V. A study of the meristem.

In the studies thus far made, the roots of *Ranunculaceæ* have all been assigned to one type, as regards their apical meristem structure, this being Erickson's third type and Janczewski's fourth. My investigations indicate that the roots do not all follow this type, some agreeing with Janczewski's third type, and on account of a modification of structure for two species, I have provisionally formed another subsidiary type.

I have not thought it necessary to describe and figure the meristem of each particular species, but will define the type, describe one representative species under it and then name the other species found to agree with this type.

1. My first type includes roots having three primary meristem tissues, the plerome, the periblem, and, in Erickson's phrase, the dermocalyptrogen, the root-cap and epidermis having a common origin. This will be seen to be Janczewski's third type, corresponding to Erickson's first type for dicotyledons. As an example of this type I describe the structure of the root tip of *Ranunculus sceleratus.*[1] In this root the epidermis can be traced from above the root-cap, thence passing beneath its layers, and ending as a distinct layer at a point near the tip of the central cylinder, as shown at *a* in the figure: at this point the cells lose their epidermal character, divide and merge into the tissue of the root-cap; the cortex, however, is distinct from the tissues on either side even at the tip, though here it is reduced to about two rows of cells, and presents an initial group of its own; likewise the central cylinder is distinctly separated from the cortex by a continuous endodermis, its initial group consisting of a few cells at the tip, thus presenting, as already pointed out, a plerome, *pl*, a periblem, *p*, and a combined initial group for the epidermis and root-cap, the dermocalyptrogen, *dc*. The other species found to agree with this in structure are: *R. circinatus*, *R. aquatilis* var. *trichophyllus*, *Clematis*

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[1]Plate IV, fig. 30.

verticillaris and probably *R. repens*, *R. bulbosus* and *R. fascicularis*, though in the last three species the roots at the very tip show to a certain degree a blending of tissues, and perhaps the plerome and periblem could be said to coalesce with the dermocalyptrogen and so belong to Erickson's third type. He certainly says *R. repens* belongs there, but my sections would indicate that the plerome and periblem were distinct in origin though slightly confused by later growth.

The roots of two plants examined differed from the first type only in that the epidermis can be traced as a distinct layer entirely about the periblem, while in the first type the epidermis ended as a distinct layer before the vegetative point was reached. In this, as in the first type, the root-cap is derived from the epidermis, for though the epidermis can be traced entirely around the vegetative point, it gives off layers of cells which are distinctly a part of the root-cap. This variation from the first type is so slight as to warrant us at most in simply establishing a subsidiary type. The structure for this subsidiary type is shown for *Ranunculus Pennsylvanicus* in plate IV, fig. 31. The epidermis is distinctly traced both by its peculiar appearance and by being a continuous, unbroken layer entirely about the tip of the cortex; the origin of root-cap cells from this layer is indicated at *a* and *b* of the figure; the cortex is of several rows of cells which are reduced to two at the tip and do not coalesce with either the epidermis on one side or the central cylinder on the other. Thus we find a distinct plerome, *pl*, and periblem, *p*, and a combined dermocalyptrogen, *dc*. It differs from the first type only in that the epidermis does not lose its identity, though giving birth to the root-cap by cell-division on its exterior side. The only other plant I certainly place in this provisional type is *R. acris*. Other species with doubt referred to the first type may possibly belong to this subsidiary type.

2. My second main type corresponds to Erickson's third type in which all the tissues merge into one at the vegetative point, that is, the initial group is a common one for all tissues. As an example of this type I have taken the root tip of *Aconitum Noveboracense*.[2] In this root the epidermis is seen to be of cells which are larger than the other cells of the root tip, and can be traced from above the root cap, thence

[2]Plate IV, figs. 32, 33.

beneath its upward projecting layers, but ending as a distinct layer at about 1^{mm} from the tip of the central cylinder, represented at *a* in the figure. Here the layer loses its epidermal character and divides to merge into the tissues of the root cap, as in the first type, the cortex of several rows of cells could be traced as distinct layers to within about 5^{mm} of the tip of the central cylinder where they divided irregularly and appeared to coalesce with the epidermal[3] and root cap tissues of this region, as shown at *b* in the figure, the central cylinder as bounded by the endodermis was distinct to within a small fraction of a millimeter from the tip, where its rows of cells ended as distinct rows and its tissues merge into those of the cortex, as shown at *i* in the figure. Thus we see that all the tissues run together at the vegetative point and the initial group is a common one.

In this type I also include : *Anemone Virginiana* and its var. *alba*, *Actæa alba*, *A. spicata* var. *rubra*, *Hepatica acutiloba*, *H. triloba*, *Cimicifuga racemosa*, *Hydrastis Canadensis*, *Trollius laxus*, *Thalictrum dioicum*, and perhaps *Ranunculus septentrionalis*, though in this latter case the plerome and periblem almost appeared to be distinct, and if so it belongs to the first type.

While I have made these three types of meristem structure for the roots of *Ranunculaceæ*, my examination has shown me that there are no hard and fast lines circumscribing these types but there are all gradations between the structure as found in *Ranunculus Pennsylvanicus*, in which the epidermis could be traced distinctly about the vegetative point, to that found in the roots of *Aconitum Noveboracense* in which the tissues quite evidently coalesced at the vegetative point. It will be seen that the larger number of species are placed in the second main type, which is the type to which the *Ranunculaceæ* studied by Erickson and Flahault were assigned, these writers being the only ones, as far as I have been able to find, who have studied the meristem of any of the *Ranunculaceæ*, and the few species they studied were mainly those not found in this country.

Of some of the species taken for study, I was unable to obtain sections of the vegetative point that showed the meristem

[3]The epidermis in this as in most of the roots studied stained differently and had an entirely different appearance, and could easily be distinguished from any other tissue.

structure, some on account of the very minute root tips, as *Anemone thalictroides* and *Coptis trifolia;* others failed of success since the material first gathered proved to be poor and then the ground had become frozen and I was unable to obtain more material. Among these latter plants, are *Thalictrum polygamum*, *Anemone Pennsylvanica*, *Ranunculus recurvatus*, *Clematis Virginiana*, *Aquilegia Canadensis* and *Caltha palustris*.

The assigning of the species to the types as I have placed them may be but provisional, for though I had sections of several root tips from each species in almost all cases, yet sometimes two sections from different roots of the same species did not appear exactly alike in their terminal structure, and a study of a greater number of roots might necessitate changing some plants from one type to another, but they certainly do not all fall under one type of structure,[4] as indicated by Erickson.

VI. Summary.

1. *Changes through secondary growth.*

In discussing the differences found in the several species of *Ranunculaceæ* examined, I have made three types of structure on the basis of the changes taking place through secondary growth.

First, those plants which show no marked change of root structure, the primitive radial type of structure persisting in the older roots. In this class I include *Ranunculus acris*, *R. Pennsylvanicus*, *R. recurvatus*, *R. septentrionalis*, *R. hispidus*, *R. fascicularis*, *R. bulbosus*, *R. multifidus*, *R. circinatus*, *R. aquatilis* var. *trichophyllus*, *Hepatica acutiloba*, *H. triloba*, *Aconitum Noveboracense*, *Trollius laxus*, and *Caltha palustris*.

Second, those plants showing a greatly marked change in the bundle area through growth of secondary xylem rays, which by their great development conceal the primitive radial type as found in the younger roots. To this class belong *Clematis Virginiana*, *C. verticillaris*, *Cimicifuga racemosa*, *Actæa alba*, *A. spicata* var. *rubra*, *Anemone Virginiana* and its var. *alba*, *A. Pennsylvanica*, *Coptis trifolia*, *Hydrastis Canadensis* and *Ranunculus sceleratus*.

Third, those plants which show in the older roots a great

[4]My study has all been upon the mature root.

development of the central cylinder and a corresponding decrease of the cortex region. This change is partly brought about by the increase of conjunctive parenchyma in the central cylinder, the xylem being all collected at the center and the phloem in several scattered rays radiating from this center. But the decrease in the cortex region of the oldest roots is mainly due to exfoliation, the epidermis and in some cases all but two rows of the cortex cells being thrown off, so that the endodermis, consisting of many very small regular cells whose walls are generally cutinized, now serves the purpose of an epidermis. This exfoliation was especially noted in the Thalictrums studied. In this type are placed but four of the plants that came under my study, viz.: *Thalictrum dioicum*, *T. polygamum*, *Anemonella thalictroides* and *Aquilegia Canadensis*.

2. *Meristem of vegetative point.*

I have found that the roots of the *Ranunculaceæ* do not all fall under one type of apical meristem structure, but that there are two main types and a possible subsidiary type to be recognized in these roots.

First, a type having a distinct plerome and periblem and a combined dermocalyptrogen. In this type I have placed *Ranunculus sceleratus*, *R. circinatus*, *R. aquatilis* var. *trichophyllus*, *Clematis verticillaris*, and probably *R. repens*, *R. fascicularis* and *R. bulbosus*.

Subsidiary type, like the first type except that the epidermis is a distinct layer entirely about the vegetative point, though giving birth to the root-cap and so having the same initial groups as the first type. Here are included but two species, *Ranunculus acris*, and *R. Pennsylvanicus*.

Second, a type in which all the tissues coalesce at the vegetative point, having but one, and this a common, initial group. This type includes the greater number of species studied and is the type in which Erickson and Flahault include the *Ranunculaceæ* studied by them. The species placed in this type are *Aconitum Noveboracense*, *Anemone Virginiana*, and its var. *alba*, *Actæa alba*, *A. spicata* var. *rubra*, *Hepatica acutiloba*, *H. triloba*, *Cimicifuga racemosa*, *Hydrastis Canadensis*, *Trollius laxis*, *Thalictrum dioicum* and perhaps *Ranunculus septentrionalis*.

VII. Acknowledgment.

The work for this article was done under the personal supervision of Prof. Wm. R. Dudley, then of Cornell University, and I have to thank him greatly, not only for the assistance he rendered me in looking up the literature of the subject, and especially in the collection of material, but also for his kindly supervision of the progress of the work.

Chicago.[5]

Explanation of Plates II–IV.

Abbreviations used: *e*, epidermis; *c*, cortex; *en*, endodermis; *c c*, central cylinder; *x*, xylem; *ph*, phloem; *pl*, plerome; *p*, periblem; *d c*, dermocalyptrogen.

All figures of transections of roots were from camera lucida drawings; of other figures the outline was from camera lucida drawings and the details were put is free hand. The scale of magnification is indicated with most figures, the line drawn being the magnification of .1mm for the lower powers of the microscope, and of .01mm for the higher powers. Of the drawings of transections of the roots shown in figs. 1 to 25, two drawings have been made of each section, one from a higher power of the microscope, showing the central cylinder, with the xylem and phloem masses, *x* and *ph*, the surrounding conjunctive parenchyma, the enclosing endodermis, *en*, and generally one or more rows of cortex cells, *c*; the other from a ¼in objective simply to show general plan of structure, and relative proportion of cortex and central cylinder, hence only part of the cells are drawn.

Plate II.—Figs. 1, 2. Ranunculus aquatilis, var. trichophyllus.—Figs. 5, 6. Ranunculus circinatus.—Figs. 5, 6. Ranunculus acris.—Figs. 7, 8. Ranunculus hispidus.—Figs. 9, 10. Ranunculus fascicularis.—Figs. 11, 12. Ranunculus multifidus.

Plate III.—Figs. 13, 14. Hepatica acutiloba.—Figs. 15, 16. Anemone Virginiana.—Figs. 17, 18. Caltha palustris.—Figs. 19, 21. Actæa alba, young root.—Fig. 20. Actæa spicata, var. rubra.—Figs. 22, 23. Aconitum Noveboracense.

Plate IV.—Fig. 24. Clematis Virginiana, older root.—Fig. 25. The same, young root.—Fig. 26. Cimicifuga racemosa, young root.—Fig. 27. The same, older root.—Fig. 28. Thalictrum polygamum, young root.—Fig. 29. Thalictrum dioicum, older root.—Fig. 30. Ranunculus sceleratus, root tip.—Fig. 31. Ranunculus Pennsylvanicus, root tip.—Fig. 32. Aconitum Noveboracense, root tip.—Fig. 33. The same, diagrammatic figure.

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[5] At the close of the two preceding parts of this paper strike out the words *University of*, as the author has no connection with the University of Chicago.

Noteworthy anatomical and physiological researches.

The plant cell and its organs.

In 1892 three important papers were published on cellular structure, while smaller papers and contributions were issued abundantly. From Sachs[1] we have a short paper; from Bütschli[2] and Wiesner[3] extensive books. The fundamental organ in the cell, according to Sachs, is "the nucleus, with that part of the protoplasm which surrounds it and governs it," and this organ is called an energid. Plurinuclear cells, therefore, are easily understood to be a system of organs, since these cells contain more than one energid, and the growth of the number of energids determines growth in general. In the continuation of his "Arbeiten" Sachs promises to give a full account of this theory.

Like Berthold,[4] Bütschli regards the protoplasmic structure as an emulsion, and in proper mixtures he has been able to produce his "Schäume," which, when microscopically examined, appear to have a structure very much like that of the protoplasm, though, as Wiesner shows, the two do not result from the same molecular forces. Consequently Bütschli sees in the process of intussusception only diffusion.

Wiesner reviews at length the theories of Schwann,[5] Nägeli,[6] Pfeffer,[7] Berthold, Strasburger,[8] and Altmann,[9] concerning cellular anatomy and physiology, and shows logical reasons why neither of these can be held as generally applicable. After showing, in a historical introduction, how the elementary structure and the growth of the living substance have been explained by previous authors, he states his own position in the following words:

"Between the visible structure of the organism and the molecular structure which is common to all matter, is an or-

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[1]Zur Zellentheorie. Flora, 1892. p. 58-63.

[2]Untersuch. üb. mikroskop. Schäume und das Protoplasma. Leipzig, Engelmann. 1892. 4°. 24 Mark.

[3]Die Elementarstruktur und das Wachsthum der lebenden Substanz. Wien. Holder. 1892. 6 Mark.

[4]Studien über Protoplasmamechanik. Leipzig. 1886.

[5]Mikroskopische Untersuchungen. Berlin. 1839.

[6]Die Stärkekörner. Zürich. 1858.

[7]Osmotische Untersuchungen. Leipzig, 1877, and Pflanzenphysiologie, I. 1881.

[8]Histologische Beiträge II. Ueber das Wachsthum der Zellhäute. Jena, 1889.

[9](a) Die Genese der Zelle. Leipzig. 1887; (b) Archiv f. Anat. und Physiol. 1889 (structure of nucleus); (c) die Elementarorganismen. Leipzig, 1890.

ganization of the simplest kind, and this I call the elementary structure." The visible structure of living beings may be studied up to a certain point, as it has been, yet it becomes almost necessary to have a further theoretical basis for the explanation of the many important results reached in the physiology of the vegetable cell, and this is furnished by the "plasome" of Wiesner. His theory has its foundation in the phenomena of division in the vegetable kingdom. Organized individuals, like nuclei, chlorophyll grains, plastids, etc., are not the elementary organisms in his mind, but, as all visible organic units in the cell are propagated by division, it is assumed that the elementary organs or plasomes are also formed and propagated this way. These plasomes "hold the specific properties of the living substance, undergo division, grow, and assimilate." Wiesner's book is written in admirable language, and will be of interest to both botanists and zoologists. It contains many useful notes, and may be regarded as being, in many respects, as important a contribution as Nägeli's "Stärkekörner" was.

Loew and Bokorny published[10] a very interesting paper, ,,*Zur Chemie der Proteosomen,*" which claims the correctness of earlier investigations against Klemms' objections. In the *Biologisches Centralblatt* XI, 5, and in *Nature* XLVI, 491, brief articles have been published on the same subject. The present paper deals almost exclusively with the "proteosomes," *i. e.*, globular masses formed in the living cells of a great many plants—*Spirogyra*, pistils of *Eugenia*, young leaves of *Mimosa pudica* and *Nymphæa Zanzibarensis*, young petals of *Drosera*, *Cyclamen*, *Tulipa*, etc.—when these are treated with a 0.5 per cent. solution of coffein or antipyrin. The proteosomes consist of "active albumen" which shows all the characteristic albumen reactions. In a Spirogyra thread the proteosomes are very easily seen when the cells are treated twenty-four hours with the solution of coffein, in which the plants keep alive for a number of days. In dead cells, however, the proteosomes have not the same properties as those mentioned above; while the globules of living cells are easily dissolved in water of 25°–30° C., those of the dead cells remain unchanged, and "display all the properties of common coagulated albumen." This latter form of proteosomes consist of "passive albumen."

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[10]Flora, 1892. Ergänzungsband, p. 117–129.

These data can very easily be verified, and they are very instructive. Another question is, whether the "active albumen" is in any way connected with the "vital power" itself, and if we have here a reaction, from which we may judge whether life is present or not. The aldehyde theory, when employed here, can explain the vital power, but it seems a little incomprehensible that the vital power should merely be based upon chemical processes. Still, whether the theoretical deductions are provable or not, we have in Loew and Bokorny's investigations a very important contribution to cellular physiology.

In spite of the many efforts to the contrary, the door is being gradually opened to cellular and molecular physiology. Logical definitions and improved methods will be a mighty support. We have no doubt that the way to molecular physiology will be through the phenomena of the *cell-life* on one side and through the phenomena of *movement* on the other hand, and we shall see more and more clearly that "there is only one kind of life and one kind of physiology for all beings."—J. CHRISTIAN BAY.

Nutrition of insectivorous plants.

N. Tischutkin made a series of investigations on the activity of micro-organisms in the nutrition of insectivorous plants,[14] which shows that in the secretion of insectivorous plants the proteid substances are altered through the influence of micro-organisms, especially bacteria; that such organisms are always living in the fluid excreted by fully developed insectivorous plants; that the process of digestion does not begin with the beginning of excretion of the digestive solution and does not occur until a sufficient number of micro-organisms are present; that the organisms effective here come from the air or from other sources; and lastly, that the part performed by the plant is only to furnish a substratum in which the micro-organisms may live. In the fluid of the secreting organs of *Pinguicula vulgaris*, *Drosera rotundifolia* and *longifolia*, *Dionaea muscipula*, and *Nepenthes Mastersi* several forms of bacteria were found, all being able to peptonize the albumen, and they were always living in the fluid. If these results prove to be correct, which is hardly to be anticipated, the theory of the digestive power of these plants together with

[14] Acta Horti Petropolitani XII, 1–19.

many biological explanations and theories will need alteration. —J. CHRISTIAN BAY.

The phylogeny of ferns.

A late paper by J. Bretland Farmer will be found to contain suggestions of special importance to botanists interested in the phylogeny of the Filices.[1] Mr. Farmer finds that the divisions of the neck canal cell of the archegonium into two by a definite, transverse wall is by no means invariable. This has been observed by Dr. Douglas H. Campbell as an occasional occurrence in Osmunda, which this author has shown to be in many respects transitional between the eusporangiate and leptosporangiate Filicineae. The doubling of the nucleus in the canal cell in species of typical leptosporangiate Filicineæ (Polypodiaceæ) has been observed frequently. These facts suggest strongly the condition of things that obtains in the neck canal cell of the liverwort archegonium. The basal wall in the young embryo is formed as in Isoetes and Equisetum, at right angles to the long axis of the archegonium. The manner in which the young sporophyte issues from the oophyte distinguishes Angiopteris from those other ferns whose embryology is known. The cotyledon and stem burst through the upper surface of the prothallium, the root boring downwards through it, while in the other ferns the cotyledon and stem issue from the lower surface through the archegonial region, and grow up around the edge of the prothallium. The prothallium is very much like the thallus of Anthoceros, with which it is often associated.

These facts add more weight to the view that the eusporangiate ferns are the more primitive and that the ancestors of the Filices were closely connected with, if not derived from, the ancestors of such liverworts as Anthoceros.

It is to be regretted that Mr. Farmer's material was insufficient to make a thorough and critical study of that phase of the life history of the plant in question.—D. M. MOTTIER.

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[1] On the Embryogeny of *Angiopteris evecta* Hoffm.: Annals of Botany VI. 265 (October, 1892).

BRIEFER ARTICLES.

The flowers of the horsechestnut.—The fertilization of our common horsechestnut (*Æsculus Hippocastanum*) is an extremely interesting study.

The flower-clusters are terminal and of mixed inflorescence. At first sight the flowers on the individual branches appear to be arranged in racemes, as well as the branches themselves, but this cannot be the case, as the flowers are all on the upper side. The lowest flower opened first and was originally the terminal one. From its pedicel arose a lateral branch, also terminated by a flower, and this process went on, till the cluster contained, on an average, about eight flowers. The method of growth is the same as that of the leafy branch of the tree, where the stronger axillary bud of the pair next the flower-cluster throws its mate to one side, making it appear lateral instead of terminal.

There are many flowers in a single thyrsus. The branches average about twenty-five on my tree, with an average of eight flowers to a branch. There are more flowers on the lower branches, for they have more time to develop. The first flowers to mature are all staminate having a rudimentary pistil only. Later, other flowers with perfect pistils appear, and these are proterogynous, the style protruding from the bud. As far as my observations extend, these are from the fourth to the sixth flowers on the branch, the later ones being exclusively staminate. They generally appear on the lower branches. The stamens in the pistillate flowers are perfect and discharge their pollen. Müller mentions a case where the stamens do not discharge, as in the maples, but I have never seen this in the horsechestnut.

The nectar in the flower is secreted by an hypogynous disk. The corolla has four or five petals; when there are but four the lower petal is absent. Each petal has a claw and two projections where the blade joins the claw. These projections are pressed tightly against the stamens, and serve to protect the nectar from the rain, and to close the path to creeping insects. The petals are white, with yellow nectar guides, which change gradually to a beautiful crimson. The colors of the cluster are therefore variegated, the older flowers having crimson, the younger yellow spots, with varying shades of color according to the age of the flower. This change of color appears to keep the bees informed which flowers are not worth visiting, for I have never seen a bee waste his time by crawling into a deeply crimson spotted flower. The entrance to the nectar is at the base of the two upper petals, the path below being cut off by the projections on the petals and the position of the stamens.

The stamens are usually seven, and are at first declined. They rise one by one as they mature, and, if we are looking at the right time, we can see the anther of a stamen that has just risen split suddenly and become covered with pollen. When this takes place, the anther stands directly in the path to the nectar.

If we number the stamens, beginning at the upper right hand stamen and continuing in the direction of the hands of a clock, and then watch the order in which the anthers mature, we shall find that it is in one of the two following series, 3, 5, 4, 7, 2, 6, 1 or 5, 3, 4, 1, 6, 2, 7. One these series is the reverse of the other, for if we count in the first instance from right to left, beginning at the upper stamen on the right side of the flower, and in the second case from left to right, beginning at the upper left hand stamen the series of numbers will be the same. We can explain this by regarding the stamens as formed from two condensed cycles of staminate leaves, arranged on the two-fifths plan, with the three upper stamens belonging to the first cycle suppressed, leaving no. 3 and 5 only of this cycle of stamens, while the other five belong to the second cycle. On this hypothesis, the order of dehiscence follows the two-fifths plan, as any one may easily study out for himself. Normally, the stamens of the second cycle would stand in front of those of the first cycle, but the rule followed seems to be that the stamens arise where there is most room in the flower-bud and cause the cycles to alternate.

According to my observations, the missing stamens are the three upper ones of the outer cycle. Eichler, in his Blüthen-diagramme gives them differently. It is quite possible that different stamens may be suppressed in different localities, and the order of dehiscence in that case would be an interesting study. There is one curious little fact relating to this theoretical explanation. The stamens numbered 3 and 5 always mature about the same time and some hours before the rest, which then follow each other closely. Might this be because they belong to the outer cycle of which two succeeding members are suppressed?

It is very clear that a bee entering the flower would brush against the stamens and become dusted with pollen, and would leave this pollen on the style of the next pistillate flower visited, for the style curves upward and stands in exactly the same relation to the path to the nectar as do the stamens. I believe the flowers, however, to be self-fertile. The honey-bees have a wicked way of crawling about under the flower and stealing the nectar, but the humble-bees appear to visit the flower always in the proper way.

A very interesting adaptation in the horsechestnut is the presence

of well-developed buds in the upper axils of the leaves in the buds containing flower-clusters. These start at once in the spring and while the flower-cluster is still young become rapidly growing branches, while the leafy branches without flower-clusters have merely latent buds in their axils. When the flower-cluster drops off a new branch is ready to carry on the old one, which has been stopped in its growth. It is an interesting speculation as to the reason of this growth of the axillary bud or pair of buds. Perhaps it is able to take place because the development of the flower-cluster requires less nourishment.—JANE H. NEWELL, *Cambridge, Mass.*

Francis Wolle.—We regret to announce the death of the Rev. Francis Wolle, which took place at his home in Bethlehem, Pa., on February 10th, after long and paiefnl illness. Mr. Wolle was born in 1817, at Jacobsburg, Pa. From 1839 onward his life was devoted to the educational work of the Moravian church, with the exception of a few years of mercantile pursuits. For twenty years, from 1861 to 1881, he was principal of the Young Ladies Seminary at Bethlehem, and for five years previous served in practically the same capacity as assistant to his brother who was principal. In 1881 infirmity compelled his retirement from these active duties.

Mr. Wolle's interest in botany dates from about 1870. He first took up the study of phanerogams in which he received much assistance from Messrs. Robert and Eugene Rau, of Bethlehem. Later Mr. Wolle engaged in the study of mosses in connection with Mr. Eugene Rau. His interest was drawn to the fresh water algae, in connection with which his name will be best known, on obtaining the beautiful work of Dr. H. C. Wood on fresh water algae, published by the Smithsonian Institution. He soon entered into correspondence with Dr. Wood and Prof. Farlow in this country; later he received much encouragemeet and assistance from Rabenhorst, Wittrock, and Nordstedt abroad, in a study which became of engrossing interest. His industry in making known our fresh water flora resulted in the publication in 1884 of his "Desmids of the United States," containing 1,100 figures on 53 colored plates. This work was practically continued in 1887 by the publication of two volumes, one of text and one of plates, on the "Fresh Water Algae of the United States," in which we have over 2,300 figures on 157 colored plates. In 1891 appeared the volume of illustrations of the "Diatomaceae of the United States," 2,300 of which fill 112 plates, and in 1892 a revised edition of the "Desmids." These works, imperfect as such pioneer labor must necessarily be, will remain as a monument of untiring industry; and when it is remembered that Mr. Wolle was his own artist, the amount

of really valuable work that he accomplished in the twenty years of his attention to botanical subjects is little more than marvellous. Of course Mr. Wolle fell into some errors from which a scientific training would have delivered him, but, spite of these, the immense value of his contributions to the knowledge of our water plants can never be forgotten.

It may be of interest also to know that Mr. Wolle was the first patentee, in 1852, of machinery for making paper bags.

We are indebted to Mr. Eugene A. Rau for papers and memoranda from which the above facts are derived. We copy from the *Moravian* a brief word as to his character:

"Unvarying kindliness was a distinguishing feature of our departed Brother's character, and his sincere urbanity endeared him to many in all classes in the community, which mourns the loss of a distinguished citizen, even as the Church will cherish his memory as that of a successful educator."

Another hybrid oak.—PLATE VIII.—Last fall an oak tree was found along the bluffs of the Kansas river opposite Manhattan, which cannot well be referred to any of the American species of *Quercus* and certainly not to any of the species native of Kansas. The bark and twig characters are those of that form of *Q. prinoides* Willd. known as *Q. Muhlenbergii* Engelm., which is the common oak of the upland woods in this vicinity. The leaves, however, are intermediate between that species and *Q. macrocarpa* Michx., which is also quite common here. Some have nearly the size and shape of the latter, while others closely resemble rather deeply lobed forms of *Q. prinoides*. But they are all pubescent beneath and have the coriaceous texture of *Q. prinoides*. The acorn is also intermediate between the two species mentioned, being much larger than that of *Q. prinoides*, and showing a tendency to be mossy fringed. The drawings were made from this specimen.

Another tree which is apparently the same form was found on the bluffs of the Blue river about three miles above Manhattan by Prof. Mason and the writer. This agrees with the first specimen except that the cups of the acorns are deeper, more turbinate at base and decidedly mossy fringed as in *Q. macrocarpa*.

These two specimens are, in the opinion of the writer, hybrids between *Q. macrocarpa* and *Q. prinoides*. The two supposed parents are abundant in this region and are the only members of the white oak section found in this part of the state.

Hybrids among the white oaks are not common. *Q. macrocarpa* hybridizes with *Q. alba*,[1] but I find no record of a hybrid between *Q. prinoides* and any other species although Vasey records one between *Q. alba* and *Q. Prinus.*[2]

Plate VIII shows the twig, acorn and two cups natural size, and leaves one-half natural size.—A. S. HITCHCOCK, *Kansas State Agricultural College, Manhattan.*

A graft hybrid.—The following example of graft hybrid came under my observation two or three years ago. The number of such cases is so small that it is perhaps worthy of description. The plant belonged to Mrs. Dixson, at present librarian of the University of Chicago. The following is her description of the method she used in grafting: "I took two strong healthy plants, one a pure white and one a pure red (single bloom geraniums) and grafted them together at the root in length sections using common grafting wax and binding with long strips of flannel. The first year there was little accomplished except to keep the plant alive. In the fall I planted it in the sunniest corner of the room with plenty of rich soil. It grew rapidly and soon flowered profusely. At first there were red flowers with blotches of white, sometimes one perfectly white petal and all of the others red. The second summer the two plants were fairly wedded into one life on conditions of absolute equality. The heads would show red and white in almost equal proportion. I remember one cluster with three white flowers, two mottled ones and the rest pure red. It lived for four years and grew to be such a bush that it had to be trained against the porch rail."

At the time I saw the plant the mixture of red and white was even more marked than the condition which Mrs. Dixson describes. One blossom had two red petals and the rest white, another had some pure red and the other mottled with white, etc. I could not discover that either plant seemed to have influenced the hybrid any more than the other one had. They were certainly fairly "wedded together."—HERBERT L. JONES, *Cambridge, Mass.*

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[1]Engelmann, Trans. St. L. Acad. Sci. III. 397. E. Hall, Amer. Ent. and Bot. 1870. 191.

[2]Bull. Torr. Bot. Club X. 25, 26.

CURRENT LITERATURE.

A notable collection of Hepaticæ.[1]

Dr. Richard Spruce, whose work on the Hepaticæ of the Amazon and the Andes of Peru and Ecuador[2] forms the most elaborate and extensive work in systematic hepaticology in recent times, has supplemented this work by issuing the most extensive series of exsiccatæ that has yet appeared among the Hepaticæ. The series represents the arduous labors of Dr. Spruce in the Andes and the valley of the Amazon, where he spent fifteen of the best years of his life in a study of that equatorial flora. It numbers 478 specimens, finely preserved, mostly in a fruiting condition, or at least with perianths which furnish most available taxonomic characters, and in abundant quantity. It will be well for those whose hepatic horizon is limited by the structure of Marchantia polymorpha, and who conceive it to be a representative hepatic, to take notice that of the above number less than a dozen are of the marchantiaceous type, and there is even a smaller representation of the other thallose groups of which Anthoceros and Riccia are types, while the foliose Jungermaniaceæ constitute the great bulk of the series, The great genus Lejeunea alone with its formidable array of sub-genera appears under 175 numbers. The student who sees only the depauperate remnant of this genus as represented in temperate latitudes, fails to form any conception of its extent or true character; some of the forms are truly luxuriant, and the diversity presented by extreme types is at first glance a point in favor of generic instead of sub-generic division of the genus; further study, however, reveals a closeness that precludes this unless it be for convenience, which is at best a weak ground for the establishing of genera.

The further study of the collection has enabled Dr. Spruce to correct some references of species that were made in his monograph, and a number of new species appear which are not accompanied by descriptions, and hence are *nomina nuda* until published, which the good Doctor will doubtless attend to at once. To show the relative number of the species of the monograph which are represented in the exsiccatæ we have made the following comparisons in the genus Plagiochila which, next to Lejeunea, is the largest and most representative of the South American flora. Sixty-nine species were described in the monograph, of which thirty-nine were described as new by Dr. Spruce; in the exsiccatae sixty-eight species appear, of which fifty-

[1] Hepaticæ Spruceanæ Amazonicæ et Andinæ, annis 1849–1860 lectæ. Malton, 1892.

[2] Trans. Bot. Soc., Edinb., XIV, 1–590, t. i–xxii (1885).

three are of the number described in the monograph, but representations of eleven of Spruce's new species are lacking. Of the fifteen species remaining, seven are now issued as new species, while the other eight represent species previously described by others.

The present work is a crowning effort of a busy life now turning seventy-five years. Long may its author be spared to complete other problems in the systematic study of his favorite group of plants.

L. M. U.

Two monographs on Characeæ.

Within a very short time of each other there have come to our table the first fascicle of each of two monographs dealing with the Characeæ of widely separated localities, namely, America and Australasia; the one by Dr. T. F. Allen, of New York City, the other by Otto Nordstedt, of the University of Lund, Sweden.[1]

The first part of Dr. Allen's Characeæ of America received high commendation. It is quoted in the introduction to Norstedt's present work as furnishing "the best introduction, in English, to the anatomy, morphology, and classification of the order." The illustrations in the present fascicle of part II, which are always the part of such a work first scanned, are very well executed. Six of them are photo-engravings by the half-tone process (erroneously spoken of in the text as "photogravures") representing mounted specimens of the plants half or full size, while the eight lithographic plates represent the habit of single plants and details of the fruit and leaves. It is unfortunate that the plates are not numbered; and it would seem that the photo-engravings deserved to have the name of the species inserted on the press rather than with a rubber stamp.

Of the character of the text we are not competent to speak except on general principles, and on these it would seem to be open to adverse criticism. And first as to typography: Dr. Allen should select and adhere to some uniform scheme for each description, and by style of type and arrangement of matter make it easier for the eye to catch the items that are sought. For instance: in one place the list of synonyms is indented, in another they are flush with the name of species; in one place we have "NITELLA OBTUSA, *Spec. nov.*," in another "NITELLA MONTANA, Sp. nov.," and in a third NITELLA MISSOURIENSIS, N. SP.;" in one description occurs a list of "LOCALITIES," while in the remainder they are embodied in the general text with no heading.

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[1] ALLEN, TIMOTHY F.—The Characeæ of America, part II, fascicle 1. Roy. 8vo., pp. 8, pl. 14. The author: New York. $1.00.

NORDSTEDT, OTTO.—Australasian Characeæ described and figured. Part 1. 4to. pp. 24, pl. 10. Friedländer & Sohn: Berlin, 1891. 7 shillings.

Such things as this, together with the lack of uniformity in the capitalization of names and the abundant typographical errors, mar the appearance of the text very much.

It would seem, in the second place, to one not a student of this group, that there was a great lack in uniformity of description of the species. Contrasted characters, or description of the same points in each species, seem to us almost indispensable for sure identification. Moreover, in modern descriptions of Characeæ we notice that measurements abound, and it would seem that additional data of this kind should be given.

These criticisms may seem trivial; but if heeded we believe that the work, which we have long looked forward to, will be even more useful than it now promises to be; and it goes without saying that every one who undertakes to name these plants must have it in his library. It is privately published and we hope the author will be liberally patronized.

Turning to the Australian work, which comes to us through the courtesy of Baron Müller, we remark that its size permits more letter press as well as larger and handsomer plates, though for practical purposes probably not better. In the text, however, we have much better arrangement and typography, as well as fuller descriptions, which are English. A key to the species of Nitella would have been useful, though probably impossible at present, from the mode of publication and the imperfection of collections. Mr. Nordstedt has undertaken the work at the solicitation of Baron Müller, who has done so much to make known the Australian flora.

It is to be hoped that both of the important monographs thus begun will be rapidly pushed toward completion.

NOTES AND NEWS.

A NEW Cycas from the island of Formosa is described and figured in the January number of the *Journal of Botany*.

DR. GEORGE VASEY died at his residence in Washington, March 4th. A biographical sketch will appear in an early number of the GAZETTE.

MR. F. V. COVILLE, heretofore Assistant Botanist in the Department of Agriculture, has been appointed chief of the Division of Botany, *vice* Dr. Vasey, deceased.

RARE AMERICAN plants recently illustrated in *Garden and Forest* are Galax aphylla (Dec. 21), Agave angustissima (Jan. 4), Aster turbinellus (Jan. 11), and Salix balsamifera (Jan. 18).

DR. J. T. ROTHROCK has severed his long connection with the botanical work of the University of Pennsylvania, and has become general secretary of the Pennsylvania Forestry Association.

THE *Bibliotheca Botanica*, heretofore published by Theodor Fischer in Cassel, is hereafter to be published by Erwin Nägele in Stuttgart. It will be edited as heretofore by Drs. Lürrsen and Hänlein.

PROF. J. C. ARTHUR's paper on "The gases in living plants", read by appointment at the Washington meeting of the American Association, has appeared in the *American Naturalist*, beginning with the January number.

THE INFLUENCE of the salts of phosphoric acid upon plants has been studied by Herr C. Loew in the case of Spirogyra. He found that it stimulated the development of chlorophyll and the general activities of the cell. In his experiments disodium phosphate was used.

M. E. GAIN has been conducting some experiments to discover the relation of moist soil and moist atmosphere to plant development. A brief summary is as follows: dry air is very favorable to the production of flowers, and moist soil is favorable; dry soil is unfavorable, and moist air very unfavorable to flowering.—*Comptes Rendus.*

MEEHAN'S MONTHLY began its third volume with the new year, and its opening number presents a colored plate of Opuntia prolifera. The leading papers, treating of notable North American plants, are valuable from the amount of information they bring together; and the smaller notes which follow contain information too important to be lost.

THE INITIAL NUMBER of the *Bulletin de l'Herbier Boissier*, under the editorial direction of M. Eugène Autran, is before us. It contains thirty-two pages and two most excellent plates. The two papers are as follows: The genera Achatocarpus and Bosia and their place in a natural system, by Schinz and Autran; and Plantæ Postianæ, by George E. Post.

MR. F. H. KNOWLTON, in an interesting paper in *Science* (Jan. 13), calls attention to the former existence of the genus Artocarpus (bread-fruit trees) in North America. As late as early Pliocene or late Miocene bread-fruit trees existed as far north as Oregon. Eucalyptus is a genus with similar history, formerly existing in North America, but compelled to disappear with changing climate.

M. LOUIS MOROT's *Journal de Botanique* continues to be full of interesting and valuable material. The number for Dec. 16th contains a new genus of Hymenomycetes, *Sirobasidium*, by Lagerheim and Patouillard; a new genus of Chinese lilies near Polygonatum, called *Aulisconema*, by Hua; a continuation of the monograph of the Orchids of France, by Camus; and the concluding part of the lichens of Carissy and neighborhood, by l'abbé Hue. The first number of the new year contains the initial part of a paper by Guignard on the development of the seed and especially the seed-coat, the present number dealing only with certain Cruciferæ; and a discussion of the relationships of the tribe Clusieæ from a general morphological and anatomical study, by Vesque.

Mr. M. L. Fernald, assistant in the Gray Herbarium, expects to spend a portion of the coming summer studying the flora of northern Aroostook county, Maine. If there seems sufficient demand, he will collect sets of the plants of this region for distribution. The endeavor will be to secure fine specimens rather than a large number of species. It is hoped that an interest may be felt in this region which has already furnished many rare and a few new species.

In a paper on the influence of parasitic fungi on their host plants[1] Mr. J. H. Wakker divides such fungi in accordance with the mode in which they influence the nutrition and growth of the hosts into four groups: *kteinophytes*, of which the only effect is chemical; *hypertrophytes*, which produce hypertrophy of the parts attacked; *isotrophytes*, with but slight chemical and direct effect; and *atrophytes*, which produce atrophy of important organs, commonly of the flower parts. His investigations concern themselves chiefly with the second group.

With the beginning of this year the *Botanische Zeitung* entered upon its second half-century of existence. Advantage has been taken of this period to make some changes in form and arrangement of matter. It is now appearing in two sections, the first issued fortnightly, with single column pages more heavily leaded, devoted exclusively to the publication of complete original articles; the second retaining the original form, weekly, and devoted to reviews of current literature.

Dr. J. S. Newberry was not a professional botanist, but his death recalls the important services he has rendered to the science of botany. Being connected with the early explorations of our western territory he had ample opportunity to collect and put upon record many new plants and interesting observations. His chief botanical attention seems to have been given to trees, and his report upon the forest trees of Northern California and Oregon is the most complete ever published. Torrey's *Newberrya* (an Ericaceous genus of two species), of the Cascade Mountains of Oregon and the coniferous forests of Northern California, commemorates his services.

In a paper touching on some points in the anatomy and physiology of the Fucoideæ[2] Barthold Hansteen describes the anatomy of Pelvetia and Sargassum, and devotes attention particularly to the assimilation products of Fucus. He concludes that a widely distributed aldehyde called fucusol, having a composition of $C_6H_4O_2$, represents the primary assimilation product; and this aldehyde bears the same relation to the first visible product, fucosan, that formic aldehyde does to starch in the higher plants, though the granules of fucosan are probably not the direct product of the chromatophores, as is the starch of higher plants, but rather the product of accumulation by the phæoplasts, which are found not only in the assimilatory system but also in the sieve-cells and the storage tissues.

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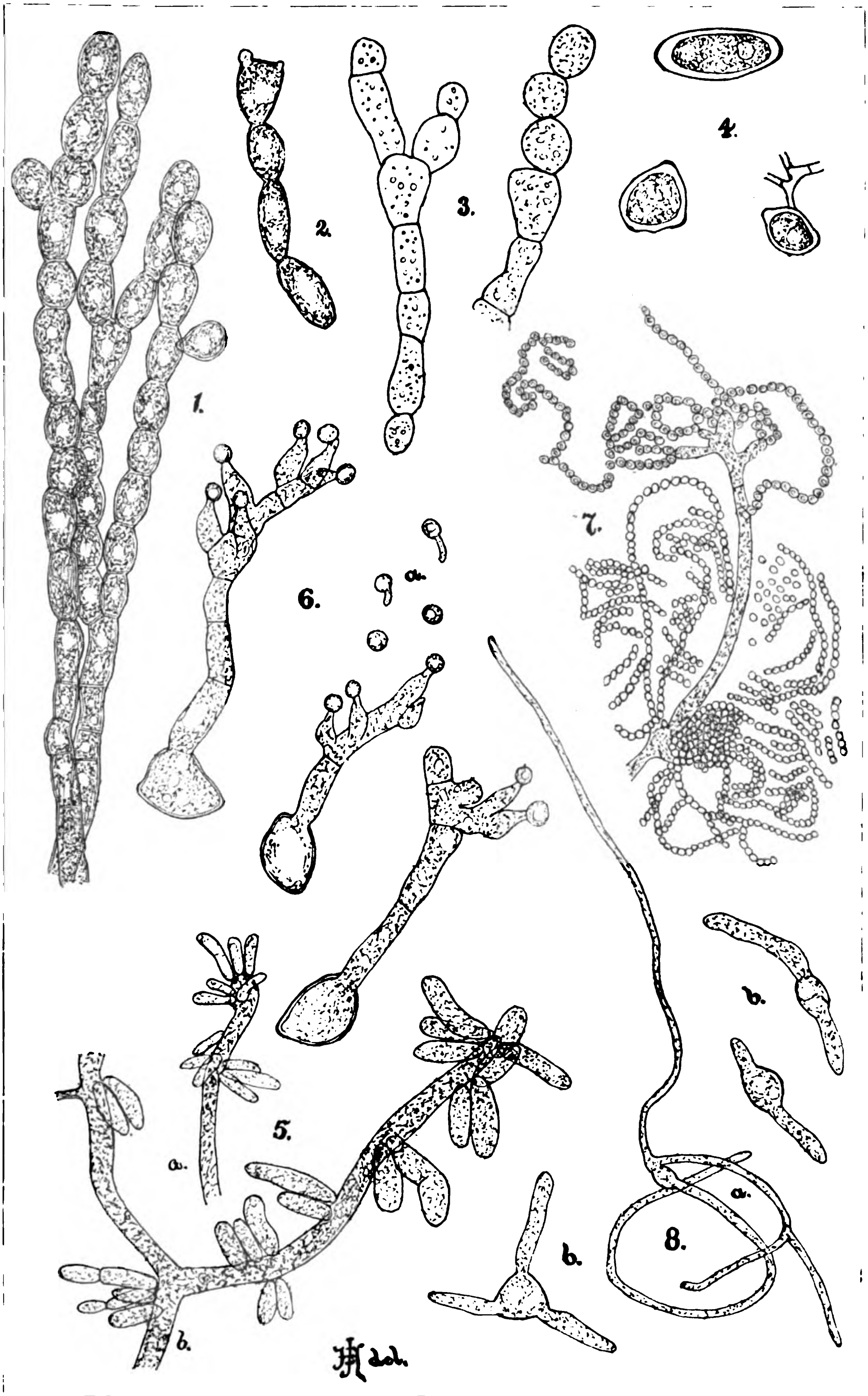
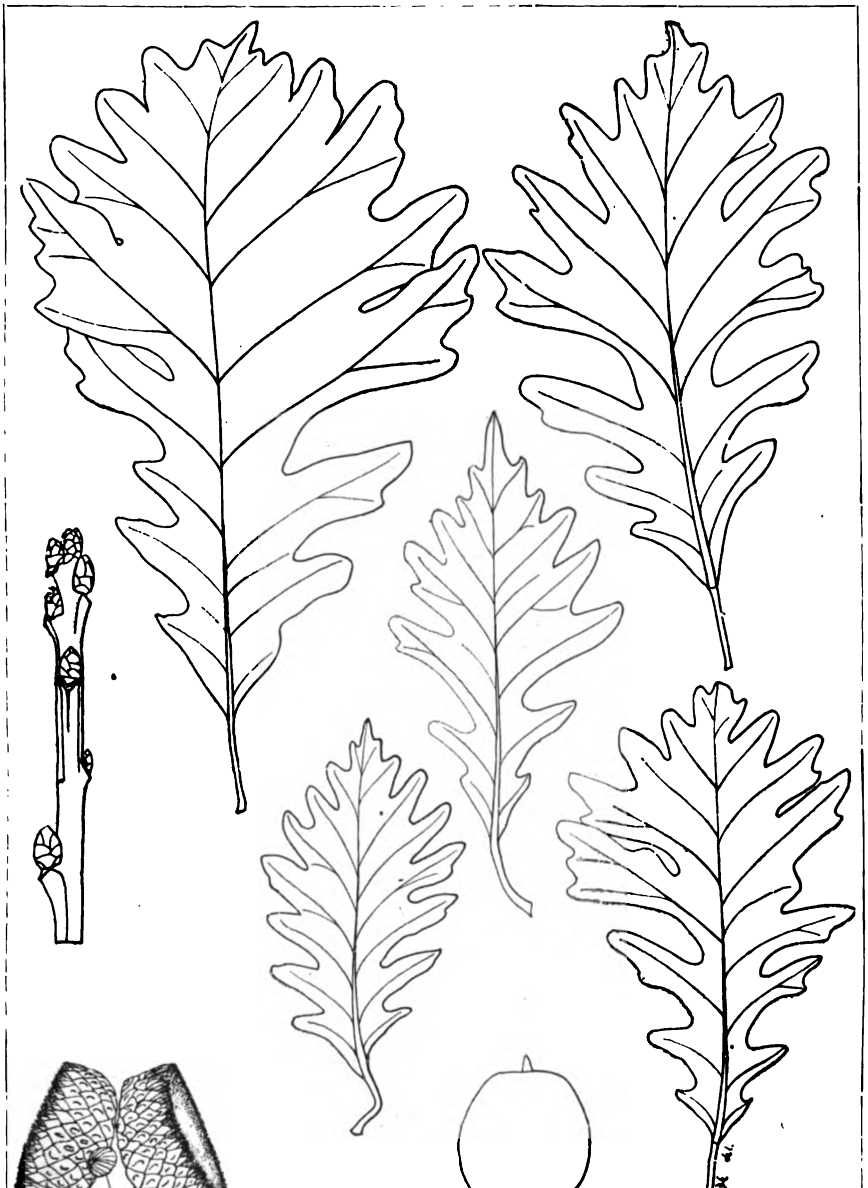
[1] Pringsheim's Jahrbücher f. wiss. Bot. xxiv. 499.

[2] Pringsheim's Jahrbücher f. wiss. Bot. xxiv. 317.



HUMPHREY on MONILIA.



HITCHCOCK on a HYBRID OAK.

BOTANICAL GAZETTE

APRIL, 1893.

Contributions from the Cryptogamic Laboratory of Harvard University. XIX.

Note on Phallogaster saccatus.

ROLAND THAXTER.

WITH PLATE IX.

During the past season the writer was so fortunate as to meet with the singular genus of *Phalloideæ* recently described by Mr. Morgan under the above name, as well as to observe its final development in connection with its earlier conditions; and since the description above referred to seems to indicate that the material on which it was based was somewhat immature, the publication of the present note seems desirable to supplement the original account. Through the courtesy of Mr. Morgan the writer has been able to compare an authentic specimen of *Phallogaster* with his own material and to determine their identity, although, as will be observed, the account here given involves some modification of the original description.

The genus presents so remarkable a departure from the type of structure common both to the *Phalleæ* and the *Clathreæ*, through the absence of any volva or receptacle differentiated as such in the mature condition, that it may not only be properly placed by itself as the type of a third subdivision of *Phallogastreæ*, but involves a distinct modification of the generally accepted definition of the family as a whole, in which its affinities are evidently rather with the *Clathreæ* than with other members of the group. Its structure is remarkably simple in a family peculiar for structural eccentricity, and, as stated by Mr. Morgan, appears to connect the phalloids more closely with the *Lycoperdaceæ* than any form hitherto discovered.

The sporophore in the present genus arises, like that of its allies, from a branching rope-like mycelium, running on or below the surface of the ground or decaying wood on which

it grows, and, though sometimes sessile, is usually raised upon a more or less clearly defined stalk, which, not infrequently, is abruptly distinguished from it (fig. 1). In section it is seen to consist (fig. 5) of a central portion, *x*, highly gelatinous even in young specimens and extending downwards, *x'*, into the stalk, while above it forms a more or less well defined central axis, *x''*, surrounded laterally and superiorly by the gleba which it penetrates in all directions, not only separating and entering its main lobes, but extending to the peridial wall within which it forms a continuous layer, *x'''*, separating these two structures, except at definite points, *y*, where they are closely united. This gelatinous portion is composed of rather slender hyphae, branching and intertwining irregularly, among which numerous vesicular clamp-connections are conspicuous, one or both of the adjacent cell ends at such points being abruptly and very considerably inflated.

The gleba, the color and minute structure of which is similar to that of other phalloids, is irregularly lobed, and, as just mentioned, is separated from the peridial wall by a gelatinous layer continuous with the other gelatinous elements. This layer is, however, interrupted at irregular intervals by certain slightly projecting areas of the inner face of the peridial wall. These prominences, which are often ill defined and are irregular in size and outline, show no signs of any differentiation which might suggest the first step towards the formation of a receptacle proper, although the gleba is continuous with them and adheres to them after its deliquescence in clearly defined aggregates (fig. 4).

The peridial wall is moderately thick and clearly distinguished from the elements contained within it. In section it is seen to be formed by a thick layer of branching septate hyphae, the successive cells of which are irregularly inflated, forming eventually a rather loose pseudo-parenchyma which is covered externally by a very thin cortical layer, composed of slender cylindrical brownish hyphae and ill defined or scarcely distinguishable at maturity, although in the youngest specimen observed, measuring 7^{mm} in diameter, it is more prominent, as would naturally follow from its origin as a continuation of the mycelial cortex. The inner face of the peridial wall is beset with prominences irregular in outline and extent and at intervals wholly absent. Seen in section certain of these prominences coalesce with the gleba lobes, while others are bounded by the gelatinous layer already referred

to as separating the gleba from the peridium. The peridial wall, moreover, does not form a homogeneous and unbroken layer, but is singularly modified by the presence of numerous depressed areas (figs. 2, 3, 6, *z*), irregular in size, shape and position, giving the surface in many specimens an irregularly reticulated appearance, which, though less distinct in fresh material, becomes well defined when the wall is slightly shrunken by drying or by treatment with alcohol. These depressions, which constitute one of the most striking peculiarities of the form in question, are filled with loosely woven more or less shriveled brownish hyphae, and do not appear to represent a special differentiation of the wall, but to have resulted from the death or non-development of its hyphae at such points during the earlier period of its growth. The function of these depressions becomes manifest when the fungus has reached maturity. At this time dehiscence takes place in two ways. In smaller specimens the peridium may become irregularly clathrate through the perforation of its wall where these areas occur, the openings being enlarged through the outward curvature of the surrounding edges (fig. 5). More frequently, however, this perforation is associated with a general dehiscence at the apex (fig. 4), first indicated by the appearance of a series of cracks in this region (figs. 2, 3), the course of which is guided to some extent by the depressed areas just described. The peridial wall thus ruptures in an irregularly stellate fashion, into several segments, which, separating from one another and becoming divergent or slightly reflexed, expose the interior surface. At the same time the larger of the depressed areas which have not been included in this cracking may become perforate (fig. 4, *a*). Meanwhile the entire contents of the peridium has become deliquescent, the main lobes of the gleba contracting and adhering to the inner face of the peridium in the form of clearly defined slimy masses, of irregular size and shape (fig. 4, *b*). In this condition the expanded funnel-shaped peridium is hollow to its very base and has assumed the function usually accomplished in the group by means of a highly specialized receptacle, exposing to the air the fetid spore masses, the removal of which is, as usual, rapidly accomplished through the agency of flies, leaving an empty shell which soon collapses and decays.

It should perhaps be mentioned that the depressed areas and resultant perforations of the peridial wall, which, as far

as can be determined from the material at hand, do not find a parallel elsewhere in the family, appear to bear no definite relation to the areas on the inner face of the peridial wall, upon which the gleba lobes are seated, including them or not without regularity.

The question of homologies between this and other phalloid genera may well be deferred till its earliest conditions are exactly known; meanwhile it would be perhaps more easy than profitable to point out by what modifications we might readily convert it into something very like the genus *Clathrus.*

In view of the above history the original diagnosis of the form may be modified as follows:

PHALLOGASTER Morgan.—Mycelium fibrous, branching. Peridium spherical to pyriform, stipitate or substipitate, consisting of a single layer covered by an evanescent cortex and coarsely reticulated through the presence of numerous irregular thin areas which become perforate at maturity, the perforation commonly associated with a general terminal dehiscence of the peridium into several divergent lobes. Gleba irregularly lobed, the lobes continuous with slight prominences from the surface of the peridium from which they are elsewhere separated by a gelatinous layer continuous with a central gelatinous axis which penetrates the gleba and separates its lobes. The entire contents deliquescent at maturity, adhering in distinct masses to the inner surface of the ruptured peridium.

PHALLOGASTER SACCATUS Morgan: Journ. Cincinnati Soc. Nat. Hist. XV, 171, plate II, Oct. 1892.—Plate IX. Solitary or rarely subcespitose. Peridium spherical to pyriform, $20–50 \times 10–25^{mm}$, stipitate or nearly sessile, the surface smooth, slightly uneven, whitish stained with dull flesh-color at maturity, becoming coarsely clathrate from the formation of irregular perforations, the perforation usually associated with a terminal dehiscence of the peridium into from three to five divergent lobes: the dark sage-green gleba adhering in definite masses of irregular size and shape to the inner face of the peridial wall. Spores greenish, sub-cylindrical $4–5.5 \times 1.5–2\mu$, 6–8 on each basidium.

Ohio (*Morgan* and *Herrick*). New York and Connecticut (*Underwood*). Maine (*Thaxter*) on the ground or rotting wood under Fagus.

Harvard University.

EXPLANATION OF PLATE IX.—*Phallogaster saccatus* Morgan. Fig. 1. Stipitate habit. Fig. 2, 3. Appearance just before dehiscence showing cracks at apex and thin areas *z*. Fig. 4. The same specimen as fig. 3, after dehiscence. *a*, perforate thin areas. *b*, deliquesced gleba masses adhering to inner face of peridial wall. Fig. 5. Smaller example which has become perforate without complete dehiscence. Fig 6. Longitudinal section of a mature specimen before dehiscence. x, x', x'', x''', gelatinous axis and its derivatives, *y* points of origin of gleba from peridial wall. *z*, thin areas in peridial wall. Fig. 7. Basidia with spores *in situ*. Fig. 8. spores.

Figs. 1–6 about natural size. Fig. 7 drawn with Leitz 1-12 oil immersion, Zeiss ocular 4. Fig. 8 Leitz 1-12 oil im. Zeiss comp. oc. 12.

The genus Cæsalpinia.

E. M. FISHER.

Following the publication of my revision of the genus *Hoffmanseggia* in Contributions National Herbarium, I. no. 5, I desire to make certain corrections and supplementary statements.

On page 144, §1, line 1 of synopsis, the reference should be to no. 2 (*H. drepanocarpa* Gray) not no. 4 (*H. gracilis* Watson).

Since *nomina nuda* are not to be recognized, *H. glabra*, var. *intricata* Fisher should read *H. intricata* Brandg.; and *H. glabra* Fisher should read *H. intricata*, var. *glabra* Fisher.

It may be well to speak of the combination *H. falcaria*, var. *demissa* Fisher. Dr. Gray, in 1852, published in Pl. Wright., in the following order, *H. densiflora* Benth. MSS., *H. stricta*, var. *demissa* Gray, and *H. stricta* Benth. MSS. *H. densiflora* Benth. is described incompletely, the fruit being wanting, and Dr. Gray remarks that he is not sure that it is distinct from the next form, *H. stricta*, var. *demissa* Gray. From an examination of the types, I concluded that *H. densiflora* is intermediate between *H. stricta* Benth. and *H. stricta*, var. *demissa* Gray. Dr. Gray's remark is sufficient to show that he doubted whether they should be separate, and his unwillingness to publish the var. *demissa* as a species (although having mature fruit) shows which he considered to be the type. Unfortunately in this case, however, the rules of nomenclature demand that *H. falcaria*, var. *demissa* (Gray) Fisher be changed to *H. falcaria*, var. *densiflora* (Benth.) Fisher.

At the time of writing the revision, it was with hesitation that it was not merged with *Cæsalpinia*. After a careful examination of the flowering parts and their tissues, in several species

of both genera, I have come to the conclusion that they must be united, even if extreme species in the two genera seem to be so unlike each other. *Hoffmanseggia caudata* Gray has more the characters of *Cæsalpinia Palmeri* Watson than any species of its own genus. Its broad oval sepals, short-clawed elliptical petals, glandless filaments, and broadly ascinaciform pod, are characters which bring it very near *C. Palmeri;* while the stipitate and black sessile glands, ovate bracts, deciduous sepals, and somewhat declined stamens, place it in an intermediate position between *Hoffmanseggia* proper, and *Pomaria.*

Bentham and Hooker have placed *Pomaria* in *Cæsalpinia* (which seems to differ from Torrey and Gray's idea), and then, speaking of *Hoffmanseggia*, say: "The genus scarcely differs from *Cæsalpinia* § *Pomaria* in habit, the sepals less imbricated and the legume thinner."

At first sight *H. falcaria* Cav. seems distinctly separate from any species of *Cæsalpinia*, but following my classification through this section to *H. intricata* Brandg., we pass to *H. caudata* Gray, and very naturally approach the section *Pomaria.* The black glandular section is very near *Pomaria* (according to Benth. and Hook.) the legumes taking on characters of *Cuilandina*, *Sappania*, etc.

Considering all these relations, and the impossibility of establishing any sure generic distinctions, since there are intermediate forms which bridge all proposed distinctions, I am compelled to follow Baillon and place our species of *Hoffmanseggia* under *Cæsalpinia.* The necessary changes in our North American species are as follows:

1. C. FALCARIA: *H. falcaria* Cav.
   - Var. STRICTA: *H. falcaria*, var. *stricta* (Benth.) Fisher.
   - Var. DENSIFLORA: *H. falcaria*, var. *demissa* (Gray) Fisher.
   - Var. RUSBYI: *H. falcaria*, var. *Rusbyi* Fisher.
   - Var. PRINGLEI: *H. falcaria*, var. *Pringlei* Fisher.
   - Var. CAPITATA: *H. falcaria*, var. *capitata* Fisher.
2. C. DREPANOCARPA: *H. drepanocarpa* Gray.
3. C. OXYCARPA: *H. oxycarpa* Benth.
4. C. WATSONI: *H. gracilis* Watson (1882), not Hook. & Arn. (1841).
5. C. GLADIATA: *H. gladiata* Benth.
6. C. PLATYCARPA: *H. platycarpa* Benth.

7. C. DRUMMONDII: *H. Drummondii* Torr. & Gray.
8. C. TEXANA: *H. Texana* Fisher.
9. C. VIRGATA: *H. microphylla* Torr. (Specific name preoccupied under *Cæsalpinia*.)
10. C. INTRICATA: *H. glabra* Fisher, var. *intricata* (Brandg.) Fisher.
    Var. GLABRA: *H. microphylla* Torr., var. *glabra* (nomen nudum) Watson. *H. glabra* Fisher.
11. C. CAUDATA: *H. caudata* Gray.
12. C. BRACHYCARPA: *H. brachycarpa* Gray.
13. C. MULTIJUGA: *H. multijuga* Watson.
14. C. MELANOSTICTA: *H. melanosticta* (Schauer) Gray.
    Var. PARRYI: *H. melanosticta*, var. *Parryi* Fisher.
    Var. GREGGII: *H. melanosticta*, var. *Greggii* Fisher.
15. C. CANESCENS: *H. canescens* Fisher.
16. C. JAMESII: *H. Jamesii* Torr. & Gray.
17. C. FRUTICOSA: *H. fruticosa* Watson.

There also may be added the following South American form, from U. S. of Colombia, that has come under my observation, and which may possibly extend to the isthmus:

18. C. VISCOSA: *H. viscosa* Hook. & Arn.

Indiana University, Bloomington, Ind.

The tendrils of Passiflora caerulea.

D. T. MAC DOUGAL.

WITH PLATE X.

II. External phenomena of irritability and coiling.

In the preceding paper[1] attention was called to the more apparent features of the development, minute structure and arrangement of the tissues, with a view to determining their value as factors in the coiling movements consequent upon irritation of the lower surface during the period of normal activity of the organ. The results recorded in this and the preceding paper were obtained by the study of plants in the green-house of the Purdue Experiment Station,[2] during the

[1] BOTANICAL GAZETTE, XVII, 205.

[2] I am indebted to Dr. J. C. Arthur for his kindness in placing at my disposal the facilities of the green-house, laboratory and apparatus, and in giving me the use of his private library, together with much valuable advice. I am also under obligations to Miss Katherine E. Golden, Assistant Botanist, for material aid.

months January—April, and September—December, 1892. The observations were extended to include *P. Pfordti* of the gardeners. The temperature varied between 16 and 35°C.

It is of interest to note that both of these forms exhibited marked nutation of the terminal internodes of the stem, since in the species examined by Darwin such was found to be the case only in *P. gracilis.*[3]

This circumnutation of the tendril and the internode bearing it begins when both are quite rudimentary(fig. 3). These movements with the individual movements of the yet immature internodes below combine to sweep the tendril through a large space during its period of greatest activity, thereby greatly increasing the probability of coming in contact with some object which may serve as a support. While this correlation is an obvious advantage, yet it must be borne in mind that nearly half the time the tendril is waving through the air with its non-sensitive surface forward, and hence could not grasp a support should it meet one. It is not necessary to suppose, however, that the tendril has reached the stage of the highest possible usefulness to the plant.

When the moving tendril, after it has attained a length of 4 or 5^{cm}, brings its sensitive surface in contact with an object which acts as a stimulus, a curve is formed at the point of contact in a time varying from 30 seconds to 2 minutes. If this happen in the early stages of growth, the curve is slight, the tissues are weak, and the tendril is dragged past or away from the support. Should the tendril have reached an approximately mature stage, the curve will be formed more rapidly, and the strengthened tissues hold the hook form given to it, and curve still further around the object. If we strike a rigid pole with a rattan cane, the curve formed will be similar to that of the young tendril, and if we strike the pole with a rope one end swinging free, the curve of the mature tendril will be obtained.

In this connection it was thought important to note to what extent the tendril would respond to various kinds of stimuli. Drops of water at ordinary temperature thrown either gently or forcefully against the tendrils produced no curvature. The contact of the ordinary metallic salts acted similarly. But if the tendril were submerged in these liquids the induced osmotic action quickly caused curves.[4]

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[3]Climbing Plants, p. 153. Vines: Phys. of Plants, p. 486.

The contact of mercury was without effect,[5] but if the meniscus of a vessel of mercury be brought forcibly against the tendril, distinct curvatures resulted.

With solids, however, it was found that it would respond to a contact as light as that made by a piece of no. 40 cotton thread, 1^{cm} in length. The results of contacts from objects of glass, woods, metals, stones, fibres, parts of its own and other plants were practically alike, and the rapidity and amount of response depended altogether upon the force of impact and roughness of the surface rather than the composition of the body. No extended experiments were made with electrical stimuli, but no results were obtained by the use of the current from a Leclanché cell.

If the temperature of the water in the previous experiment were raised to 40°C. curves were produced; or if a small rod heated to 50°C. were held near the tendril like results followed. If the water were in the form of snow or ice no curvatures could be obtained, although the hard crystals must have given a very distinct mechanical contact. The results from these high and low temperature stimuli are doubtless due to their direct influence on the osmotic action of the cells, since in the experiment with the heated rod the tendril can be made to curve backward.

Darwin notes that the tendrils of *Bryonia dioica*, and also *Echinocystis lobata*, would not form curves when mutually interlocked. His generalizations can not be extended to the species of Passiflora examined. If a small portion of an excised tendril be placed on an active tendril a temporary curve results, and it was noticed that two tendrils brought against each other almost always formed curves, and the fact that they did not always interlock was due to the fact that both were in rapid motion in opposite directions, and were quickly dragged past. Should any of the tendrils be fixed taut the other may coil around it as has been demonstrated numerous times (fig. 2, c). In one case five tendrils formed a mass of mutual coils. The tendril has also been noted to grasp and crush into a mass in its coils the leaves of its own body, perhaps the one from its own axil. Such action could not even remotely be of any use to the plant, and in view of these facts it is

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[4] BOTANICAL GAZETTE, XVII. 207.

[5] See also Pfeffer: Untersuchungen aus dem Botanischen Institut zu Tübingen, I. 491.

impossible to ascribe to them any great degree of selective intelligence.

The tendrils can coil in such manner as to fasten to almost any object except a polished plane surface. If the object be a cord or a twig the free end coils around it as in the rope experiment, while the portion between the plant and the support is thrown into spiral coils. If a board whose width is nearly equal the length of the tendril be placed in contact with it, the tip will hook around the farther edge while a few spirals are formed which lie flat on the surface. Thus it will be seen that the size of the object which may be grasped is limited only by the length of the tendril, while it can grasp an object however small since the tendril can coil so closely as to obliterate the central enclosed space. This adaptation was still further shown by the manner in which it fastens to the crevices of a brick wall. In doing this the tendril tip finds its way into the small surface cavities of the bricks and forms coils, filling up the cavity in such manner that it can not be dislodged without rupturing the tissues.

Tendrils thrust into smooth glass tubes 2^{mm} in diameter formed curves throughout their entire length, while the more flexible tip formed a solid spiral completely filling up the bore of the tube. It required a force of $10–20^{gm}$ to dislodge such tendrils. Still others placed in tubes scarcely larger than themselves could not be withdrawn without breaking or crushing the tube.

If a tendril during its period of irritability does not come in contact with any object reacting as a stimulus, it will, on completing its growth, slowly form into a continuous right or left handed irregular spiral.

Should the tendril grasp some object with a portion of its tip, the portion in contact with the object grows slightly in length and by its manner of curvature forces its tip farther around the object if it is not too large, and at the same time increases the thickness of the part in contact, as a reactive result of the pressure. The tendril may grasp an object any time during its period of activity, but the part between the support and base will not form spirals until it has attained its maturity, which is from a few hours to two days later. Now the immediate cause of coiling is the inequality of length of the upper and lower sides of the tendril. How this inequality is brought about need not concern us at this point. If the tendency to curve were strongest at the tip and decreased to

zero at the basal portion, the free tendril would coil in the form of a helix and no torsions would result. The strength of the curving power, and of the tendril, are so proportioned that the resulting spirals are all 0.3^{cm} to 0.5^{cm} in diameter and can not lie concentrically, but must form side by side. This means, of course, that torsions are set up. In the free coiling tendril it can revolve and relieve these torsions. In the tendril fastened at both ends, however, this is impossible and if the spirals were all in one direction the torsion would be great enough to work serious injury. The fastened tendril begins to form spirals either near the base or the support on reaching maturity. This part coiling with its spirals all in one direction of course twists the contiguous straight part of the tendril. This twisting continues until the induced torsion is stronger than the coiling force of the first part, and then the twisted part forms coils in the opposite direction in obedience to its own torsion. The portion in which the two forces are equalized will be nearly straight. The remainder of the uncoiled tendril is acted upon similarly until it is coiled in two to seven portions separated by straight parts. The number of the portions will be determined by the relative value of the coiling force and the resistance of the tendril. While the number of spirals in any portion may not be the same as in another portion of the same tendril yet the total number of turns in either direction are invariably equal. The time elapsing between fastening to a support and the formation of spirals leads to the conclusion that the latter is not a direct result of irritability, but rather a function of the mature tendril.

When a straight tendril fastens to a support and afterward forms spirals in the portion between its base and the support, it must tend to bring these two points nearer, unless the tendril has at the same time a growth in length to compensate for the spirals, such as was found to be the case in Cucurbita by Penhallow.[6] Extended observations were made to determine if the distance between the base of the tendril at the body of the plant and the support were brought any nearer, and if so what force was exerted in so doing. Repeated measurements disclosed the fact that the tendril drew the portion of the vine near its base toward the support a distance of 1 to 6^{cm} or as much as one-third its length.

Weights of three grams upward were suspended from the

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[6]Canadian Record of Science, II. 242. Oct. 1886.

tips of tendrils by means of loops of soft cotton cord to determine their lifting strength. With weights less than six grams many close spirals were formed lifting the weights several centimeters. With the increase of weight, more open spirals resulted. Still higher only weak curves were made, while tendrils weighted with twenty grams were held entirely straight, and this may be safely taken as the limit of the lifting power (fig. 3). These effects, however, are modified by effect of the traction of the weights on the tendril.[7]

The results obtained by the dynamometers are doubtless of greater value. Of these, three types were used. One form consisted of a spiral spring of brass suspended from a hook in an upright wooden standard after the manner of the Joly gravity balance. The tendril is fastened to the lower end of the spring and the amount of tension determined by an arbitrary scale. The second form was the lever dynamometer which is in general use and needs no description here.[8]

The most satisfactory results, however, were obtained from the use of Vöchting's dynamometer.[9] This machine is designed for use with a clinostat, but can be used in determining tensions of all kinds. It is simple, convenient and reliable. (See plate X.) It consists essentially of two compass arms of metal 10^{cm} and 6^{cm} in length, separated by a spring (s). The long arm (c) carries the spring and the short pointer (d) and is curved back a short distance below the pointer (l) and tapers uniformly throughout to the lower end which is a sharpened point. The shorter arm (b) joins the longer arm by an ordinary hinge joint. This arm tapers to the lower end, terminating in a small hook (e), and carries the arc scale (f) which slides under the pointer. The scale is marked into fifteen divisions so arranged that a pull on the hook (e) will be indicated in grams by the pointer. The spring (s) is made of gold for greater reliability, and is fastened to the long arm by two small screws. The other end slides freely along the shorter arm as the pressure varies. In the plate the machine is shown registering a tension of $2\frac{1}{2}^{gm}$ of a tendril of *Passiflora Pfordti.*

The plant at the base of the tendril is attached by cords to an iron post (n) driven firmly in a board. The long arm of the dynamometer is driven into the board in such position that

[7] W. Pfeffer: Ber. Verhandl. K. Sachs. Gesell. Wiss. v. 638–643. (1892.)
[8] Pfeffer: Die periodischen Bewegungen der Blattorgane, 1875.
[9] Berichte der. deutchen bot. Gesellschaft, vi. 279. (1888).

the straight tendril will pass the curved portion without touching, and catch the hooked end of the short arm with its curved tip. Any tension set up is indicated directly on the scale. The tendrils tested with this type of dynamometer exhibited tensions of 3 to 10^{gm}.

The function of the tendril is doubtless to pull the growing shoot up toward the light and fix it to a support. It occupies a supra-axillary position and the internodes are from 3 to 10^{cm} in length. The work of each tendril as it in succession comes to maturity is to lift its internode and the undeveloped internodes of the growing shoot. On testing it was found that this portion of the plant never reached a weight of 1^{gm}, and the amount to be lifted by two adjoining tendrils rarely exceeds 1.5^{gm}. Thus it will be seen that each tendril is capable of doing the work of many. The value of this provision is apparent when it is known that not all of the tendrils are able to reach supports, others are injured or rendered incapable of grasping objects by the force of the winds, and that the firmness with which a plant is held has a direct influence on its growth.

The coiling of the attached tendrils and the subsequent strengthening of their tissues give them the elasticity of springs and enable them to withstand severe shocks and strains without injury. The force required to tear a plant from its supports must first straighten the coils and then rupture the tendril. No measurements were made of the tensile strength, but it was found that normally coiled and mature tendrils required a force of 350 to 750^{gm}—the weight of several feet of the plant body—to break them, so that the probability of a vine, firmly anchored by dozens of these tendrils, being torn from its fastenings, is very remote.

Briefly summarized, the tendrils and terminal internodes of the two species of Passiflora examined show circumnutation. The tendrils are sensitive to contact of solids, and liquids at a temperature of 40°C., and are non-sensitive to liquids at ordinary and low temperatures, unless they are so applied as to induce direct osmotic action, and to slight electrical stimuli. Coiling around an object takes place on contact, while formation of spirals takes place on maturity. The formation of the spirals exerts a tension of three to twenty grams, shortening the tendril one third of its length, and a mature tendril can withstand a strain of 350 to 750^{gm}.

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EXPLANATION OF PLATE X.

Figure 1. *Passiflora Pfordti;* Vöchting's dynamometer attached to tendril; B, short arm, C, long arm, D, pointer, E, hook, F, scale, L, curve of long arm, S, spring, N, iron post.

Figure 2. *Passiflora cærulea;* A, tendril carrying weight of nineteen grams, slightly curved near base, B, tendril carrying weight of nine grams, spiral near tip, C, tendril grasping tendril B, which it has pulled from the perpendicular.

Figure 3. *Passiflora cærulea;* A, growing tip of shoot with undeveloped tendrils, B, tendril slightly sensitive and nutating, C, tendril capable of coiling, D, tendril nearly mature—in the period of highest activity.

The limitation of the term "spore."

CONWAY MAC MILLAN.

Every one who has attempted to define his terms of daily use has probably met with the same experience that the writer might describe. Words, easily definable at first, become more and more vague as their implication is more fully understood. In view of the scantiness of botanical terminology, although it is one of the richest of scientific vocabularies, there is great need that the import of common terms should be examined with much care to avoid the errors of over-, or under-definition. Every work that appears presents some new and generally barbarous verbal technicalities that tend rather to cloud than to clarify perception, For example in that most excellent little compendium on the cryptogamic plants, lately published from Bennett and Murray, one is grieved to find that the word "sperm," properly employed in plant, as in animal, biology, is diverted to a peculiarly unnecessary meaning and is taken as a synonym of the phrase "fertilized egg," when it would have been much preferable to unify the terminology by calling the antherozoid of the plant a "sperm," and thus recognizing what it is necessary to recognize as fully as may be that the animal and the plant are alike, for the higher groups of organisms, in producing sexual cells and that these cells are, even in their intimate mitotic phenomena of development, strictly analogous, if not absolutely homologous.

At present I wish to speak in particular about the use of the word "spore" in botanical writing, and it is not intended to offer any historical or highly exhaustive discussion at this time, but simply to show how under the general term there are a number of ideas that clear thinking demands should be kept separate. In the first place it may be noted that the

term spore is not used here as having any connection with the so-called "oospores" of the books, for they are surely better given some other name, since they are products of gametic union. The same may be said of the "zygospores" of the Conjugatæ. The word is therefore limited here under the well known definition, "a spore is an originally perfect cell specialised for purposes of reproduction."

Nor is it intended to examine the various categories of spores which present in their terminology some idea of their formation, as for example the æcidiospores, sporula, chlamydospores, conidiospores, sporidia, teleutospores, ascospores, etc., of the mycologist. The word is to be taken only in its general sense. It will be seen however, that clear definition demands that the spore shall have some phylogenetic limitation as well as the ordinary morphological or physiological or embryological limitation. It thus happens that one is compelled to examine the course along which the higher types of spores have developed. It will then appear that the use of the word in different orders of plants is always with a group of reservations peculiar to the particular plant, or series of plants, in question.

The spore appears in its generalized form in such plants as the bacteria and among low algæ, such as the Protococci, the Chroococci or Palmellaceæ. Here it is a cell which must be defined by setting it over against the ordinary vegetative cell of its plant. In *Bacillus anthracis*, for example, the spore is but little different from the ordinary cell and may be limited very properly by considering it an ordinary cell in which such slight specializations as have appeared are directed towards the withstanding of temperature changes and other external influences that might be dangerous if not made the basis of an adjustment. Such spores as these may be considered as generalized and basal, and may for the purposes of this classification be known as *primospores*.

In the well known *Ulothrix*, and in plants above, but near its plane we find that the primospores become themselves a subject for further differentiation and they function either as spores or as gametes, in the lower plants of this division, while in the upper the specialization is perfected to heterogamy. In Ulothrix and its allies, then, the spore is not only to be set over in contradistinction to the ordinary vegetative cell but it is also limited from the imperfect reproductive cells,

the gametes, and thus acquires a new meaning. Spores of this type may be termed here *secundospores*.

In *Œdogonium* the sporophytic structures emerge. The well known facts of Œdogonium life history need not here be detailed. It will be remembered that the fertilized egg undergoes rejuvenescence and segments into usually four spores, motile and similar to the spores of the gametophytic generation which are themselves of the secundospore type. The spores thus formed as the result of sporophytic segmentation may be distinguished very well under the name of *tertiospores*. They are characteristic of the Œdogonium series and are more generalized than other sporophytic spore structures.

Passing to *Riccia* and its allies, we encounter the fourth type of spore, from the point of view of this classification. In Riccia the segmentation of the fertilized egg proceeds until a structure is developed that consists not only of spores but of enclosing, protective and more or less vegetative cells. In this case, the reverse process to that observed in the lower plants has taken place. Instead of spores emerging from the modification of vegetative cells one finds vegetative cells tracing back to spore cells. Indeed, therefore, the whole vegetative system of higher plants may be considered as developed from a series of reproductive cells as seen in Œdogonium, while in the series below the emergence of the sporophyte the spore cells must be considered as an emergence from that more generalized type of cell which is at once reproductive and vegetative. Such spore cells as those of Riccia, since they must be defined as developed with the by-cells of the segmentation, are to be held in contradistinction with the vegetative sporophytic structures. Such spores, following the terminology, may be known as *quartospores*.

While bisexuality of gametophytic plants may originate without a preliminary morphological differentiation of the spore, as for example in *Equisetum*, nevertheless it happens that the sex of the plant to be produced from the spore may be predetermined not only in the inner activities of the spore but in its size, shape and general structure. In this way heterospory appears and we discover in such excellently investigated plants as *Pilularia*, *Isoetes* or *Selaginella* among the so-called cryptogams and in *Taxus*, *Lilium* or *Narcissus* among the so-called phanerogams a predetermination of the sex of the plant to be produced, long before the spore that is to produce the plant is itself mature. In cases like this,

whether it be the pollen spore of the composite, the embryo-sac-spore of *Casuarina* or the less modified heterospore of *Marsilia* or *Azolla* or *Isoetes*, it becomes impossible to define the spore without attention to the sexual *potentiality* of the cell and the function of its plant-product that is to be the result of germination. Such spores as have undergone this profound morphological differentiation with regard to the sex of the plant to be produced from them may be given the name of *quintospores*.

It seems clear that in the great lines of development of the vegetable kingdom there are these five types of spores to be distinguished one from another. To each of them the term *spore* is ordinarily applied but, as I have attempted to show, with a widely different implication in each case. The word *spore*, then, in the Bacteriaceæ stands for a very different structure than does the same word in the Compositæ. It may be objected that this is but to transfer new ideas into the word and thus make it more difficult to comprehend. The objection is hardly well taken, I think, for it is evident that the analysis does not read anything into the word that has not already, by common consent, been included in its meaning.

Of the five phylogenetic types of spores, if I may name them so, the first two belong to the plants below the sporophytic emergence. It is remarkable that these types of spores, so fully represented low in the scale, are so completely lost as one passes higher. In Œdogonium both secundospores and tertiospores are formed, but in the gametophyte of the Muscineæ, only a short distance above, they seem to be wanting. The suggestion might be made that the propagative cells of the archegoniate gametophyte may be the representatives of the secundospores of Œdogonium. Gemmæ of *Marchantia* or *Tetraphis* might be thus homologized and would then either appear to be multiple spores like those of some of the fungi, as *Macrosporium* or *Cladosporium*, or would be the result of a development from an original spore-cell. In any case the view here indicated, that the persistence of the secundospore would be a fruitful study, may be productive of some results. Again, the notion that the vegetative cells of sporophytic structures may be traced back to tertiospores, gives some additional light, it may be, upon the high degree of vegetative propagation, so-called, that goes on in higher sporophytic structures. Vegetative development being the acquired state of the cell it would be possible to ex-

plain the propagative activity that often makes itself apparent even in highly specialized organs, as the leaf of the Begonia, by the laws of reversion, and vegetative propagation would become atavistic in its implication. Entirely apart, however, from speculations like these it seems well to insist upon the close examination of even so common a term as the word "spore," for any increase in exactness is an impetus to thought, that should not be underestimated.

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The range of variation in species of Erythronium.

M. E. MEADS.

WITH PLATE XI.

About a year ago while working upon plant variations, some interesting variations of *Erythronium Americanum* were found of which I could find no record. During the past two years I have made a careful study of the two species, *E. Americanum* and *E. albidum*, with the view of ascertaining the limits of their variations. Over four hundred specimens have been examined, and the results seem to warrant publication.

According to the best authorities the principal specific differences of the two species lie in the stigmas and color of perianth; E. Americanum having an entire, club-shaped stigma, while the stigma of E. albidum is three-cleft and spreading. In the fifth plant of E. Americanum that I examined the stigmas were not united; they were 3.2^{mm} in length with a spread of 3^{mm}, and of fifty-three plants of which I took careful measurements, only seven had the stigmas united, the length of the stigmas ranging from 1.3^{mm} to 7.1^{mm}. As may be seen in figs. 1–3, the stigmas of E. Americanum are not recurved; fig. 10, on a much larger scale, shows this more clearly and also shows the contracted appearance, *d*, just below the apex; measurements for the spread of the stigma were taken above this at line *a;* these measurements range from 1.3^{mm} to 3.6^{mm}.

Owing to the curve of the stigma of E. albidum, it was impossible to take accurate measurements of the length; there is, however, a considerable range, although not as great as in E. Americanum. The spread of the stigma of this species,

figs. 5–7, in twenty plants from which I took measurements, varies from 1.1^{mm} to 4.6^{mm}. Fig. 11 represents diagrammatically the upper surface of a stigma, line *bc* showing where these measurements were taken. Sometimes the stigma has the contracted appearance of E. Americanum, fig. 7; in such cases the plant can only be identified by the color of the perianth.

A distinction has been made between the leaves of E. Americanum and E. albidum, regarding shape, size and markings. So far as my observations go, this is a distinction without a difference. I have found patches of E. Americanum where the leaves were entirely without blotches, and the leaves of E. albidum are frequently as deeply mottled as are ever found in E. Americanum. The shape in both species varies from broadly oval to nearly linear, and the size varies as greatly.

Another species, *E. mesochoreum*, has recently been claimed for Kansas. The noteworthy differences between E. albidum and E. mesochoreum, as given, are, briefly:

"*E. albidum* Nutt.—Leaves lance-elliptical, more or less mottled with purple or light green blotches; cross section of ovary blunt, triangular, with sides concave because of narrowed partitions; sterile forms propagated by paired underground runners which develop new corms at their extremities.

"*E. mesochoreum* Knerr.—Leaves much longer and more narrow, almost linear, never mottled; cross section of ovary bluntly triangular, with sides convex because of wider partitions; new corms developed at the base within the old; no runners."

In a dozen leaves of E. albidum of which I took measurements the length was from four to nineteen times greater than breadth; some of the leaves being nearly linear. According to Torrey the leaves of E. albidum are not marked. This spring I examined about a dozen plants of E. mesochoreum, kindly furnished me by Mr. Knerr. Among them was one plant, otherwise answering perfectly to the description of E. mesochoreum, with leaves deeply mottled with purple. Fig. 12 shows, on an enlarged scale, a cross section of an ovary of E. mesochoreum. It may not be a typical form, but answers the description the best of any in the material furnished me. While the sides of the ovary of E. albidum are usually concave, they are sometimes convex, figs. 13 and 14. I have examined about twenty corms of E. albidum,

and fig. 9 is a good type of what I have found in various stages of development in nearly all of them. This is also commonly found in E. Americanum. The following note from BOTANICAL GAZETTE, II (June, 1877) may throw further light on this species.

"The normal E. albidum from Illinois to western Iowa, noted for spotted broad leaves and very recurved petals, is confined to groves; while a much smaller form from western Iowa to Kansas confined to prairies has narrow leaves, never spotted, petals never recurved, not half the height of the former. The difference is doubtless due to soil and locality.—R. Burgess, Ames, Iowa."

The above seems to indicate that E. mesochoreum instead of being a true species is but a variety marked by certain variations constant in it, and found, but not constant, in E. albidum.

I took careful measurements of every part of the flower of E. Americanum and E. albidum, and plotted the curves according to the method used by Alfred Russell Wallace in animal variations. Comparing the results of thirty-four specimens of each, we find the length and width of the petal, length of stamens and ovary, and length and spread of stigma are closely correlated in E. Americanum. In E. albidum the variations of the length of the petals and ovary are more loosely correlated. The other parts vary independently, sometimes seeming to follow the variations of these, and again when a decided variation in some direction is looked for, varying not at all or even decidedly in the opposite direction. The general variations of the two plants are in an opposite direction, toward each other. This is shown by comparing the mean measurements of the different parts and the variations from that, in the following manner:

Length of	*Species.*	*Mean.*	*Number above the mean*	*Number below the mean*
Petal	Americanum	32.65^{mm}	19	15
Petal	albidum	34.45^{mm}	15	19
Style	Americanum	10.25^{mm}	23	11
Style	albidum	11.1^{mm}	11	21
Ovary	Americanum	10^{mm}	5	29
Ovary	albidum	8.25^{mm}	19	15

In all the plants of E. Americanum that I have examined I have found in the stamens a tendency to heteromorphism, fig. 8. In fifty-three plants from which I took measurements the mean difference was 2.65^{mm}, the greatest difference I have recorded is 4.5^{mm}, but I am convinced that some of which I was unable to get measurements had a greater difference even than this. Designating the longer set as *A* and the shorter as *B*, and comparing as above, we have:

Set.	*Mean.*	*Above mean.*	*Below mean.*
A	21.15^{mm}	27	26
B	18.5^{mm}	25	27

showing that the ratio of the two sets of stamens is nearly constant, with a very slight tendency to increased difference in length. This tendency to heteromorphism of stamens is also found in E. albidum, but is not so general, and as yet I have no measurements from them. In connection with this difference of length of stamens may be mentioned the fact that the pollen sacs of the shorter ones uniformly burst open before those of the longer; also the remarkably large number of cases found in which the pollen was not developed at all, the flower being pistillate with rudimentary stamens. In these individuals the anthers were yellow, while the fertile anthers are a dark brown or brownish red. Further study will be made upon these points.

Authorities seem agreed that the fertile form of Erythronium is two-leaved. I have frequently found three-leaved plants in both E. Americanum and E. albidum; the third leaf appears later than the other two, pushing up into view while the plant is in bloom.

My experiments in cross fertilization have not yet been carried out sufficiently to warrant any conclusions in this regard.

With us E. albidum grows in very rich, wet soil in the low, well shaded parts of beech woods; E. Americanum is found in the drier soil near, but grows more abundantly in the dry soil of the high, open parts, seeming to prefer clay to the rich leaf mould.

I wish to express my indebtedness to Prof. Hicks and Prof. Wheeler, of Michigan Agricultural College, for literature on this subject. Also to Prof. McFarland, of Olivet College,

for the interest he has taken and the assistance he has so kindly given in the work.

Biological Laboratory, Olivet College.

EXPLANATION OF PLATE XI.—Figs. 1–7, pistil of Erythronium Americanum; 5–7, pistil of E. albidum; 8, E. Americanum showing different length stamens; 9, corm of E. albidum; 10, stigma of E. Americanum, *a*, line of measurement, *d*, contracted part; 11, upper surface of stigma of E. albidum, *bc*, line of measurement; 12, cross-section of ovary of E. mesochoreum; 13, 14, cross-sections of ovary of E. albidum.

Noteworthy anatomical and physiological researches.

Anatomy of the tubers of Equisetum.

Leclerc du Sablon, describing the anatomy of these organs of *Equisetum*,[1] shows that they represent short branches reduced to a single internode. These tubers are situated upon the rhizome; they are able, when detached, to develop independent individuals. They are pear-shaped in *Equisetum Telmateja*, occurring in clusters of two or three at a node of the rhizome. A transverse section shows a very thin cuticle which has no incrustation of silica, and a starch-bearing parenchyma just inside the epidermis. This parenchyma entirely surrounds the central part of the tuber including the ring of fibro-vascular bundles. Each bundle is again surrounded by an endodermis, the radial walls of which show the spots named after Caspary. There is no lacune to be observed in the hadrome, which, in most cases is characteristic of the oldest part of the stem above ground in the *Equisetaceæ;* and the vessels are present in a still larger number in the tuber. These vessels are not arranged in any order, but scattered and intermixed with parenchymatic cells. The largest ones are not always situated in the outer part of the entire bundle, but are irregularly mixed with the smaller ones, and do not show the shape of a *V*, which characterizes the bundles of the stem. Towards the apex the bundles increase in number and unite to form a crown which corresponds to the terminal node of the tuber. Such anastomosing bundles are not known elsewhere in the internodes of the rhizomes of *Equisetaceæ.*

The most important character in the structure of these tubers, and by which they differ from the rhizome, are: The division of the endodermis into special endodermes, surround-

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[1] Sur les tubercules des Equisétacées: Revue générale de Botanique, IV. (1892.) no. 39.

ing each bundle; the absence of lacunes in the hadrome; and the irregular arrangement of the vessels.

In contrast to *Equisetum Telmateja*, mentioned above, the tubers of *E. sylvaticum* are ovoid and arranged so as to form a rosary; but the structure agrees very well with that of the preceding species, except that some layers of the bark-parenchyma are strongly thickened so as to form a kind of protecting sheath around the central part of the tuber, which peculiarity is, also, to be observed in the rhizome of this species.—THEO. HOLM.

Yeast fungi.

Professor Emil Christian Hansen upholds[2] the correctness of statements concerning endogenous spore-formation in the cells of Saccharomyces, against the opposition of Moeller, to whose paper the February GAZETTE called attention. Hansen gives a short review of spore-formation in this division of fungi, the conclusion of which is that the spores possess a membrane and germinating power. Very likely Moeller has confounded oil-drops and similar formations often found in old cells, with the true spores. It is incomprehensible that anybody can doubt the formation of endogenous spores in Saccharomyces. But of course we have to follow strictly the rules given by Hansen.[3]

Prof. Groenlund[4] has established four new yeast fungi, namely, *Saccharomyces Ilicis I* and *II* (both found on *Ilex*), *S. Aquifolii*, and *Torula Novæ-Carlsbergiæ*. The three Saccharomyces are found producing spores and the new species are based upon the relation of this phenomenon to temperature. The Torula gives beer a very unpleasant and bitter taste.—J. CHRISTIAN BAY.

Soluble pentoses in plants.

De Chalmot[5] gives in his studies on the pentoses in the plants a very important contribution to the chemistry of assimilation. The so-called "pentosanes" of Tollens[6] are widely distributed in the plants. These give pentoses by hydrolysis, and two sugars, arabinose and xylose, have been

[2]Centralbl. f. Bakteriol. und Parasitenkunde, XIII, (1893) 16.
[3]Meddelelser fra Carlsberg Laboratoriet, II, (1886) 152–167; III, (1891) 53–78.
[4]Zeitschr. f. d. gesammte Brauwesen, no. 30-32, 1892.
[5]Reprint from the American Chemical Journal, XV, no. 1. (1893.)
[6]Die landwirtschaftlichen Versuchsstationen, XXXIX, 401 (1891), esp. pp. 425—430.

obtained from them. The theory of assimilation, given by Baeyer, which assumes that formic aldehyde, being the first product of assimilation, is the origin of the carbohydrates, has been supported by the fact established by Bokorny[7], that sodium-oxymethylsulphonic acid could supply the amount of carbon wanted by Spirogyra.

All the natural pentoses so far known belong to the *l*-series, and all the natural hexoses to the *d*-series. Plants by assimilation either form hexoses and pentoses, or have the power to change *d*- into *l*-compounds. The theory of Baeyer, does not make it improbable that both pentoses and hexoses are formed. This work was undertaken to determine the limits of the reactions. Soluble pentoses which could be identified as wandering substances were sought.

It was possible in all cases which were examined to show the presence of soluble substances which form furfurol; but these substances might be hexoses which furnish traces of furfurol. On this account it was necessary to estimate how much furfurol the hexoses which were present could form and how much in fact was formed.

For the estimation of small amounts of furfurol a method was devised which depended on the color reaction of furfurol and an acetic acid solution of aniline. It was proved that the amount of hexoses present was not sufficient to explain the formation of all the furfurol and therefore soluble pentoses were present. Leaves and colorless bark were used for the experiments. The soluble pentoses are easily diffusible through membranes. The fact leads to the conclusion that the soluble pentoses are simple sugars, $C_5 H_{10} O_5$. The investigation confirmed the belief that the small amount of soluble pentoses is not perceptibly diminished by the death of the leaves. In the leaves of the oak there was found in the evening a small but evident excess in the amount of soluble pentoses over that found in the morning. Joined to this is the hypothesis that the soluble pentoses are temporarily converted into stable forms directly after their formation by the process of assimilation.

This paper forms a very important appendix to the long and fundamental paper by Tollens and his students from 1891 cited above. De Chalmot promises a further discussion of his hypothesis.—J. CHRISTIAN BAY.

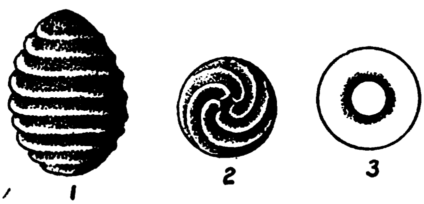
[7] Biologisches Centralblatt, XXII, September, (1892.)

BRIEFER ARTICLES.

Description of a new fossil species of Chara.—In a former volume of this journal[1] I described, under the name of *Chara compressa*, a Chara fruit from the Wasatch group or lower Tertiary rocks of Wales, Utah. That species was well characterized by being longitudinally much depressed, the height being at least one fifth less than the width. The apex was obtuse or even slightly depressed and the number of spirals, as observed in side view, ten. This was the first North American species founded upon the 'fruits,' and I am now able to add a second equally well characterized species.

Chara Stantoni, n. sp. (Fig. 1, 2, 3.).—Fruit (sporostegium) oblong-elliptical in general outline, slightly smaller at apex, obtuse, nearly one fifth longer than wide (0.63^{mm} long, 0.48^{mm} in diameter); number of spirals as observed in side view eight or nine; cells furrowed, separated by thin, low projecting ridges.

This species was obtained by Mr. T. W. Stanton of the United States Geological Survey, for whom I take pleasure in naming it, from the west side of Smith's Fork of the Bear River, about 20 miles north of Cookville, Wyoming, in a locality that is of great geological interest. The horizon is the Bear River formation, which was long known as the Bear River Laramie, but which Mr. Stanton has shown[2] to belong to the lower part of the upper Cretaceous. The 'fruits' are scattered in considerable numbers throughout certain layers of the section, in a matrix of hard fine-grained bluish shaly limestone. They are associated with large numbers of fresh-water shells, among them *Pyrgulifera humerosa* Meek, *Corbula pyriformis* Meek, *Unio vetustus* Meek, *Limnæa nitidula* Meek, *L. haldemani* White and *Neritina naticiformis* White. The 'fruits' and shells are all perfectly silicified and were liberated from the matrix by disolving the limestone in acid.



CHARA STANTONI, n. sp.

This is one of the smallest fossil species known. As stated in the diagnosis, the sporostegia average 0.63^{mm} by 0.48^{mm}. The longest specimen measured was $0.70^{mm}$and the shortest 0.60^{mm}. The largest diameter observed was 0.51^{mm} and the smallest 0.45^{mm}. In several instances specimens were found that had been fractured in the middle,

[1]XIII (1888). 156, 157, figs 1, 2.
[2]The Stratigraphic Position of the Bear River Formation. Am. Journ. Sci. XLIII, 98–115. Feb. 1892.

thus presenting a perfect cross-section (fig. 3). The central portion, corresponding to the oöspore was filled with nearly white silica, while the portion that was originally the wall of cellulose surrounding the oöspore was bluish in color. The furrows on the fruit (see fig. 1), caused by the five enveloping cells of the sporostegium, are separated by rather prominent ridges, but the walls are not marked with dots or processes as is so frequently the case. The base (fig. 2) showing the origin of the five enveloping cells, presents a small five sided orifice which answers to the point of attachment.

Among the 60 or more species that have been described in a fossil state, there are several that resemble *Chara Stantoni* in general appearance, but when more closely examined it is found that they all differ in size or number of cells exposed in side view, and as these are characters of great constancy it serves clearly to distinguish them. The geological position of this species prove it to be one of the oldest yet described. So far as now known the genus Chara had its origin in the Triassic, where it is represented by a single species. The Jurassic has two species, the Cretaceous very few, while the most are found in the upper Tertiary. — F. H. KNOWLTON, *U. S. National Museum, Washington, D. C.*

Is Cypripedium spectabile poisonous to the touch?—In the *Torrey Bulletin*, VI, 15 it is stated on the authority of the late Prof. H. H. Babcock of Chicago that after handling *Cypripedium spectabile* or *C. pubescens* he found himself suffering from a severe attack of skin poison. He had taken great pains to keep clear of *Rhus toxicodendron*, but notwithstanding, the same symptons continued several successive seasons at a time when he was accustomed to handle the Cypripedium. The possibility of any effect of this kind was discredited at the time (*Torr. Bull.* VI, 22) nor did it seem credible. Some years later a similar case occurred in this vicinity and was reported to me by the attending physician. A lady near whose home grew a fine clump of Cypripedium spectabile had been in the habit of gathering it when in bloom and using it sometimes for home decoration and sometimes for the decoration of the church. At such times for four or five successive seasons she suffered from syptoms of Rhus poisoning, but on careful examination no Rhus could be found where the Cypripedium grew. These symptoms invariably appeared whenever the Cypripedium was in the house and disappeared with its removal, and on her removal to another part of the country never re-appeared. In fact, when she ceased collecting the plant she escaped entirely.

A third instance of a similar kind occurred in this part of the country in connection with one of my own students who had always been in the habit of handling Rhus with impunity and had done so for years.

Not long since he was severely poisoned immediately after having gathered and handled a large quantity of Cypripedium spectabile and in view of the above facts very naturally attributes his trouble to this plant.

The above is largely circumstantial evidence, it is true, but any one who has examined Dr. James C. White's *Dermatitis Venenata* cannot but suspect that there are not a few plants, harmless in the case of the great majority of those who handle them, which nevertheless may be harmful to certain persons of peculiar temperaments and susceptibilities.—Henry G. Jesup, *Hanover, N. H.*

The pine grosbeak's attack on the ashes and spruces of Cambridge, Mass., in January, 1893.—For several days preceding January 15th, Cambridge received a visit from an unprecedented number of pine grosbeaks from the north. Flocks of hundreds filled the trees and grounds here and there throughout the city. Mr. William Brewster, the ornithologist, says that it is not at all strange to see a few of these birds during the winter, and that about every third year, they are apt to visit this region in considerable numbers, owing probably to a scarcity of food in their native home.

What they fed on chiefly, during their last visit, was the seeds of the ash and the buds of the spruces. They would attack a large ash tree, laden with fruit, and in a few hours strip off every key. Their method was to take the key in the beak, deftly split open the outer covering of the base of the fruit, and extract the seed. This Mr. Brewster saw them doing by hundreds, as he stood close by under the trees. The birds were so tame, in fact, that one could stand close up to them, within reaching distance, but they would hop away quickly, if an attempt was made to catch them. I was unfortunate myself, in not seeing the birds shelling the ash keys, but I did see the snow under the trees literally covered by the fallen fruit, and my herbarium contains a pocket full of the remnants left by the birds. As a rule, the key was entire, with the exception of the slit in the ovary, the slit running quite through both sides. Generally the wing was untouched, but sometimes it was split clean through. This divided the key into two parts, but I think the action was not at all intentional on the part of the bird, his object naturally being merely to get the seed.

The birds almost completely stripped the spruces of their buds, and I am much interested to know what effect this treatment will have on the growth of the trees. The Norway spruce is our common species, and though, as in the case of the ashes, I did not see the birds at work, I saw and made a careful examination of the havoc which they committed. Here again I have Mr. Brewster's testimony to the wonderful sight afforded by these voracious birds. The spruces were laden with

snow which had recently fallen, and, as the birds plied, on every branch, their unwearied task, a thin veil of snow was continually shaken to the ground, and through it the bright colored beams of the newly risen sun cast a rosy light. The buds, terminal and axillary, of the Norway spruce, are small, and the birds left on the tree the scales of the lower half, extracting the rest to the very base of the bud. The reason for this would appear to be, that there is a natural point of division, half way between the base and the end of the bud, the scales on the lower half being, apparently. tougher and more firmly attached to the stem. The natural instinct and experience of the bird would teach him to attack the bud at the weakest point. From the base of the bud thus extracted, the bird would quickly pick out the small nucleus of tender tissue, the germ of the next year's growth of stem or inflorescence. This growing point I found to be just the size of the head of an ordinary pin, so that it is no wonder that the poor hungry grosbeak was not to be satisfied in a short time.

The bird, having picked out this nucleus, would throw the remnant to the ground, and the snowy carpet beneath the trees was thickly covered with bud scales, which were lying either separately or in the shape of the little bud as it was picked from the tree. A small hole under the bud showed where the vegetative cone had once been. I carefully examined portions of one large spruce, and I was unable to find a single bud intact. I have heard that a judicious pruning of the buds of a tree by the feathered tribe gives new vigor to the tree, but what will be the effect of this wholesale slaughter? I shall watch the trees with interest this spring, when the buds should begin to unfold.

The grosbeaks were here but a few days. As soon as they had exhausted the food supply, they departed for new fields. It is to be hoped that they have already satisfied their boundless appetites, and given the remaining spruces, at least, a chance to awake in the spring from their winter's nap.—Walter Deane, *Cambridge, Mass.*, Jan. 22, 1893.

EDITORIAL.

Attention should be called to the work of the standing committee of the American Association on Biological Nomenclature. This Committee is the American representative of a proposed International Committee, having been appointed in response to a request from the Australasian Association. The movement promises to be as extensive as the original intention, and the American Committee, composed of

Goodale, Coulter, Gill, Minot, and Gage, have gone seriously to work to prepare their contribution to the work of the International Committee, the larger share of which, it is but just to say, has fallen upon Professor Gage. In these days, when investigation is being multiplied so enormously, and new terms are being constantly coined, a uniform system of nomenclature in morphology is becoming no less desirable than in systematic work. The committee has formulated certain underlying principles to guide in the selection of a biological terminology, and it is the desire of the GAZETTE to call the attention of American botanists to these principles. The first is that the names of organs and parts, and terms indicating position and direction, should be single designatory words so far as possible, rather than descriptive phrases. The necessity for this becomes more apparent in zoological anatomy, where the names of men are often applied to anatomical structures, than in botanical, where the tendency is to follow this rule, though there are notable exceptions. Another principle, which would have a good deal to do with botanical terminology, suggests that morphological terms should be etymologically correct, and so far as possible derived from Greek or Latin, and that each term should have a Latin form. Such phrases as " antipodal-cells," "sieve-tubes," etc., etc., would disappear under both of these principles. Another important principle recommends that each of the technical words have, in addition to its proper Latin form, a form which shall make it conform to the genius of the various languages, that is, that a paronym be made for each technical word. This is really a very important suggestion, and the word would be so slightly changed that one familiar with its classical form would recognize it instantly in either Italian, French, German, or English. There can be no doubt that if this principle of paronyms was adhered to the intelligibility of scientific writing would be greatly increased. The word "Biology" itself is an excellent example of what is meant. Whether "Biologia," "La Biologia," "La Biologie," "Die Biologie," or "Biology," it is always recognizable.

The Committee also urgently recommend that whenever a technical word is used for the first time, the author should give, in a special note, the Latin form, the etymology, the proper paronym for his own language, and as concise and precise a definition of the term as possible. This is surely a reasonable price to pay for the introduction of a new term. This exactness of definition should be as much demanded as the exact description of a new species.

It is also a very desirable thing to unify botanical and zoological morphology so far as possible. The subject is a very difficult one, and such a movement would necessarily be slow, but it was begun when the name protoplasm was adopted for the same substance in both

plants and animals. All this involves the preparation by the International Committee of an authoritative glossary of biological terms, and the keeping of a systematic record of new terms. Like many other movements toward desired uniformity, its first result will probably be seen in the adoption by individual biologists of a conscious and systematic plan of terminology. It will not be very troublesome to unify future action; but the serious conflict will come when there is a demand to make to conform to new rules whatever of ancient terminology conflicts with them. However, American botanists should encourage this movement in every way, and it would be well to consider the subject at their next general meeting.

CURRENT LITERATURE.

The flora of Minnesota.

Minnesota has provided so liberally for its geological and natural history survey that the scientific men of other states might well feel envious. The first report[1] of the present state botanist has now been distributed and the size of the volume and excellent typography speak well for the wealth of material and opportunity for its creditable presentation. It is surprising how much can be said concerning a comparatively limited flora when one industriously studies it and begins to look at it from many points of view. Professor MacMillan has set a very high mark for state catalogues, and one that it is probably not necessary to reach in many cases. The introduction to the volume was previously distributed and noticed in this journal. In a preface the author agrees to follow the Rochester agreement and indicates the changes it would make in the nomenclature of the catalogue, the body of which was beyond his control at the time of the Rochester meeting. Although not in harmony with all the details of that agreement, the author frankly accepts them in the interest of uniformity, and if this spirit is universal American systematic botany has been emancipated from the fetish of names and can begin to study plants.

The list begins with the lower Metaspermæ and ends with the Compositæ. The Polypetalæ and Apetalæ are merged, as they ought to be, under the name Archichlamydeæ. Naturally this merging is very

[1] MacMillan, Conway.—The Metaspermæ of the Minnesota Valley. A list of the higher seed-producing plants indigenous to the drainage-basin of the Minnesota River. Reports of the Geological and Natural History Survey of Minnesota, Botanical series, I. pp. xiii. 826, with two maps.

tentative as our knowledge of the phylogeny of these groups lies chiefly in the future, but it is just as well to express the little knowledge we have. The details of the list are carefully worked out as follows: name of family, with authors, synonyms and dates: number of genera and their general distribution; approximate number of species; name of genus, with author, place and date of publication; synonyms and dates; number and distribution of living species; number of extinct species if any have been recorded; name of species, with full synonymy, dates, etc.; North American and local distribution; representation in Minnesota collections. It will be seen that this gives a very large amount of information concerning the bibliography and range of each plant and will be of very great service to botanists. The list is summarised as follows: families, 106; genera, 407; species and varieties, 1174.

In our limited space it will be impossible to fully notice the general discussion of the metaspermic flora of the Minnesota Valley as contained in the last 200 pages. All the features of the valley which have to do with plant-life are first discussed, and this is followed by a very full consideration of the problems of geographical distribution in general and the local forces in particular which have had to do with the origin of the Minnesota flora. Numerous tables of statistics are given, and a full index closes the volume. Professor MacMillan is to be congratulated upon this very full and complete presentation of the subject he has had in hand. It must have involved an immense amount of careful and confining work, but we are confident that his labor has not been in vain.

Minor Notices.

THE SECONDARY EFFECTS OF POLLINATION have been presented in an able paper by W. M. Munson,[1] who has critically collated a very large number of published observations on the subject, chiefly from English and American sources. His own extended researches make his opinion especially valuable. Among the conclusions at which he arrives the following are especially prominent: Within certain restricted limits there is an immediate influence of pollen on the mother plant; the pea, kidney bean and Indian corn show unmistakable evidence of immediate effect of foreign pollen, while curcurbitaceous and solanaceous plants exhibit no immediate effect; the form and size of tomato plants are directly dependent upon the amount of pollen furnished; the egg-plant and English forcing cucumber are the best examples of organic development of fruit.

[1] Annual Report of Maine Agricultural Experiment Station, 1892, part II. pp. 29-58. Illustrated. Issued under separate cover.

Dr. William Trelease, although fully occupied by the cares of the directorship of the Missouri Botanical Garden, finds time to publish periodically, and the periods are getting shorter, pieces of work that serve well to continue the reputation that Dr. Englemann brought to St. Louis. We have before us his further studies[1] upon that fascinating subject, the pollination of Yuccas. Dr. Trelease has had further opportunity of studying Yuccas in the field and has added a large amount of valuable information concerning this interesting group. Three species of Pronuba are now known to act as pollinators, and it is predicted that others will be found. After giving detailed notes of the various species, the author gives an interesting discussion as to the probable former range of Yucca and its adaptation to Pronuba pollination. It seems to be fairly well made out that the genus was formerly of much wider and more northern range, has been driven southward, and is now preserved in favoring localities. It also seems more than probable that ancestral forms had separate spreading stigmatic lobes, which by their union have formed "the peculiar stigmatic chamber into which the pollen must be thrust in order to properly develop its tubes and fertilize the ovules." The separation of these stigmatic lobes has been observed both in Hesperoyucca and the true Yuccas. It is naturally to be supposed that the evolution of Pronuba has gone "hand in hand with the adaptation of the Yuccas to their services in pollination," an evolution which Professor Riley has broadly sketched. A very interesting biological fact is, that a variety of Y. Whipplei (*y. graminifolia* Wood) has as its pollinator a black variety (described here as new) of the Spotted Pronuba which pollinates the species. Another suggestive fact is that Pronuba yuccasella accompanies the true Yuccas across the continent, and in California pollinates Y. baccata, and at the same time is associated with three other forms which are pollinators of Pacific types. Twenty-three excellent plates illustrate the paper, showing various species of Yucca, and Pronuba with dissections.

Mr. Charles Robertson, whose studies on the relation of flowers and insects are well known to the readers of the Botanical Gazette, has just distributed the results of his studies among the Labiatæ.[2] The group is one of special interest in this connection, and after presenting details of observations Mr. Robertson discusses the family as to its flower forms, pointing out the least and most specialized ones and their probable origin. The unremitting attention which Mr. Robertson has given to this work has brought together a vast body of facts, which will presently represent all of our entomophilous groups.

[1] Trelease, William.—Further studies of Yuccas and their pollination. From 4th annual report of Mo. Bot. Garden. pp. 181-226, plates 23.

[2] Robertson, Charles.—Flowers and Insects—Labiatæ. Trans. St. Louis Acad. Sci. vi. 101-131.

MR. HENRY WILLEY has long been identified with the critical study of North American lichens, and since the death of Professor Tuckerman has been our lichenologist of largest experience. He has issued a pamphlet,[1] which he says terminates his thirty years' labor on the New Bedford lichens. Of the 369 species enumerated thirty-nine were new when first discovered, the present paper containing four not previously defined. The author expresses his regret "that the American professors of botany have so generally accepted the 'Schwendener theory,' as it is called, that lichens have no independent existence, but consist only of a fungus associated with an alga; and this, too, simply as a dogma, without having acquainted themselves with the arguments against it by the prominent lichenographers of Europe, and by Professor Tuckerman, in this country, and without having made any special studies of the plants themselves. These arguments constitute a considerable body of literature, of which none of these professors seem to have more than a little if any knowledge." A retort to this would be easy; but Mr. Willey can rest assured that whether lichens are to preserve their autonomy or are to be considered as wonderful examples of symbiosis they will always excite much interest and long be in need of critical study.

BOTANISTS who were present at the Washington meeting of the American Association, will remember Professor J. M. MacFarlane's public address upon plant hybrids. The full paper,[2] of which the address was simply a brief popular account, has now been distributed. The author has recorded fully his investigation of nine hybrids and their parents. He has, in every case, compared the three individuals as to external characters and internal structure, and has discovered that in every particular the hybrid has an intermediate character. The results he gives as to abundance and kinds of plant hairs, the distribution of stomata, the nature of the various tissues, even the structure of starch-grains and other cell-contents, show a remarkable intermingling of the characters of both parents. The bearing of these facts upon current biological problems is discussed, but from our point of view the facts presented tend more to substantiate such views as those of Weismann and his school than to discredit them.

PROFESSOR A. S. HITCHCOCK has just distributed the report of his

[1] WILLEY, HENRY.— Enumeration of the Lichens found in New Bedford, Mass., and its vicinity, from 1862 to 1892. 8vo. 40 pp. Printed for the author, New Bedford, 1892. 50 cents.

[2] MACFARLANE, J. MUIRHEAD.—A comparison of the minute structure of plant hybrids with that of their parents, and its bearing on biological problems. Reprinted from Transactions of the Royal Society of Edinburgh xxxvii. pt. 1. no. 14. pp. 203–286. pls. 8.

expedition to the West Indies[1] during the winter of 1890-91. It consists of a list of the plants collected, together with a discussion of the Bahama flora, in which it seems evident that it is of southern origin. The few pages of the preface are chiefly devoted to discussing matters of nomenclature. In this the author was particularly fortunate in the delay of publication so that he is able to present a list which conforms to the Rochester agreement. Knowing something of the difficulties of collecting in the West Indies, and of determining the material when collected, the writer must congratulate Professor Hitchcock upon the length of the list and the very careful way in which it is presented. Every genus and species bears its date, a thing which will presen·ly be as necessary as the author.

MR. W. W. ROWLEE has distributed a paper (with five plates), reprinted from January number of the *Bulletin* of the Torrey Botanical Club, on akenes and seedlings of Compositæ. He has studied various facts of structure and phenomena of germination. Very naturally, this detailed study of structure has shown that some of our generalizations have been too sweeping. His study of seedlings is compactly and clearly put, and is a valuable addition to the mass of similar facts being collected.

PROFESSOR ALBERT A. WRIGHT, of Oberlin, has issued a supplement to his list of the "Flowering and Fern Plants" of Lorain county, Ohio, (published in 1889). The list hereafter is to be referred to as Laboratory Bulletin no. 1. Over 100 new members have been added, making the total enumeration of species 931.

THE THIRTY-FIRST "Contribution from the herbarium of Columbia College"[2] deals with the genus *Polygonum*. Mr. Small recognizes seventy-nine American species and gives their range and synonymy. Two new Mexican species of PERSICARIA are described and some manuscript names and *nomina nuda* defined.

"THE OPENING of the buds of some woody plants" is the title of a recent paper[3] by Professor Hitchcock. It is a series of notes taken during the spring of 1892. The field is a new and good one, and the study of twigs or winter-condition of shrubs and trees will presently have a literature of its own.

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[1] HITCHCOCK, A. S.—Plants of the Bahamas, Jamaica and Grand Cayman. From 4th Annual Rep. of Mo. Bot. Garden. Issued March 9, 1893. pp. 47–180, with 4 plates.

[2] SMALL, JOHN K.—A preliminary list of American species of Polygonum. Reprinted from Bull. Torr. Bot. Club XIX, 351–370.

[3] HITCHCOCK, A. S.—The opening of the buds of some woody plants. Trans. St. Louis Acad. Sci. VI. 133-141. 4 plates.

OPEN LETTERS.

That "probably carnivorous" Polyporus.

I am much obliged to Mr. Cook for his helpful criticism in the March GAZETTE of my note in the November number. The points that he makes strike me as generally well taken and it was because of my recognition of their force that I entitled my note a "*probable* new category of carnivorous plants." I intended to make plain to all readers that my interpretation of the facts was a purely tentative one. I am not yet sure, however, that *Polyporus applanatus* does not digest the unfortunate flies. I distinctly stated that the production of new pores was *not* while the fly was in "high relief" upon the surface, but after the fly was *thoroughly digested.* In this case the "surface area" was not larger than before though the pores were more numerous and somewhat smaller than upon a similar area where no fly had been captured. Thus Mr. Cook's objection, and his principal objection, seems to be scarcely to the point. To be sure I speak of the flies "raising the hymenial level," but since this is a tabular not a rounded excrescence there is really no increase in poriferous surface. The statement was, however, not sufficiently clear and I readily see how it led Mr. Cook astray. I take pleasure in amending it. And again, it occurs to me that the illustration given by Mr. Cook of the way in which the Polyporus hymenophores "grow around" small twigs, etc., is hardly applicable to this case. It is not the general growth that encloses the fly but a renewed putting forth of hyphæ from the interior of the pores, apparently under the stimulation of the fly's presence. This struck me at the time and still appears to me to be noteworthy.

The little flies that I examined really did "lie flat upon the surface of the hymenophore." Perhaps this was due to prolonged tetanic contractions of the interesting muscles in their legs. But I leave that to Mr. Cook.—CONWAY MACMILLAN, *University of Minnesota.*

NOTES AND NEWS.

MR. J. G. BAKER is publishing in the *Gardeners' Chronicle* a synopsis of the species of *Canna.*

MR. A. A. HELLER has published a preliminary list of the lichens of Lancaster county, Penn.

A SPECIMEN of Cereus senilis ("old man cactus") which has been in cultivation in England for about sixty years has grown only about three inches in all that period.

THE PROTECTION of plants against snails has been studied by L. Piccioli, who finds that such substances as tannic acid, latex, essential oils, raphides, etc., furnish the chief protection.

DURING THE coming season Mr. Charles W. Armstrong, of Toronto, intends to go thoroughly into the flora of York county, Canada. He will collect sets of plants for specialists in any group above bryophytes.

THE AMERICAN literature of compass plants is cited and commented upon in the January number of the *Deutsche botanische Monatsschrift* by J. Christian Bay of the Missouri Botanic Garden. Seventeen articles are mentioned.

MR. F. L. SARGENT advocates in *The Household* the claims of the Columbine to be the national flower. He finds in it the Phrygian liberty cap, the five-pointed star, the cornucopia, the thirteen original states, and the red-white-and-blue!

A NEW FORM of plant press is figured and described in Queen's *Microscopical Bulletin* for February. It is made of wood, held together with straps, and has elastic bands to keep the unused papers in place. It weighs but 22 ounces without papers, and will doubtless prove a popular press for field work.

DR. KARL PRANTL, professor of botany and director of the botanic garden of the University of Breslau, died in that city on the 24th of February. Dr. Prantl is also well known as an author of many valuable works; as the editor of *Hedwigia*; and as the joint editor, with Engler, of *Die natürlichen Pflanzenfamilien*.

IN *Proc. Philad. Acad.* for 1892 (pp. 357-365) is the beginning of another botanical series by Professor E. L. Greene, under the title "Eclogae Botanicae." Under the name of *Carduus* a number of new western thistles are described, and the old ones transferred. Three new lupines are also described, one from Colorado, the other two from California.

NOLL DESCRIBES[1] two lecture experiments, one showing the visual influence of the coloring matter of Florideæ; another showing a heliotropic experiment with the sporangia of Pilobolus crystallinus placed in the Sachs heliotropic camera[2] or a modification of this instrument. Both of the experiments are suited to catch the student's attention.—BAY.

THE QUESTION of the root-tubercles of Leguminosae bids fair to become still more complicated. B. Frank and H. Moeller are engaged in a discussion concerning an announcement by the former that Pisum sativum has two kinds of tubercles, differing in position, size and content; a thing which the latter claims is simply due to difference in age.

OBSERVATIONS on root tubercles upon both indigenous and introduced plants of the northwest, made by Prof. H. L. Bolley (Agricultural Science, VII, 58) indicates that such tubercles are common upon all native species of the order, as well as upon introduced species. But the latter were often without tubercles when growing upon virgin soil, especially when not more than one season old.

MR. THOMAS HOWELL, in *Erythea* (Feb.), has suggested a rearrangement of American *Portulaceæ*. It has chiefly to do with the delimitation of Claytonia, Montia, and Calandrinia. A new genus, *Oreobroma*, is proposed, "named in allusion to the edible fleshy roots," and contain-

[1] Flora LXXVII, pp. 27-37.

[2] Vorlesungen, 1887, p. 737.

ing species taken out of Calandrinia, Lewisia, and Claytonia, to the number of ten. Professor Greene had already previously transferred species of other Claytonia to Montia.

WHILE DETMER (on the nature and importance of the physiological units in the plant)[1] is broadening out the plasome-theory of Wiesner, assuming that the life is closely connected with the "living albumen-molecule"[2], we find Crato[3] adding a contribution to the theory of Bütschli, assuming the applicability of the comb structure in the protoplasm. Detmer's paper is a very valuable contribution to the physiological theory of cell-structure.—BAY.

PROFESSOR J. VON SACHS has finished the publication of his collected works on vegetable physiology, which collection, however, does not comprise all of his papers, but only the most important of his many contributions. The two stout volumes will, of course, be one of the things that the botanical student has to read. Notes under the text show the renowned investigator's altered views on many subjects, many of these notes being very illustrative. The plates accompanying many of the papers have been replaced by figures in the text.—BAY.

A NEW anthracnose of privet (Ligustrum vulgare) is described and figured by Geo. F. Atkinson in a recent bulletin of the Cornell station (No. 49). It attacks the twigs forming brown, depressed spots, which sooner or later extend around the stem and cut off the supply of sap to the portion above, thus killing the twig. Pure cultures on nutrient agar-agar were studied. The fungus proves to be a new species, and is described under the name of Gloeosporium cingulatum, being closely related to G. fructigenum, which causes the ripe rot of apples.

THE International Standing Committee on nomenclature, appointed at the Genoa congress is as follows: *Germany*, Ascherson, Engler, Radlkofer; *France*, Baillon, Bureau, Malinvaud; *England*, Baker, Clarke, Hooker; *Russia*, Batalin, Schmalhausen; *Switzerland*, DeCandolle; *Italy*, Caruel, Saccardo; *Austria*, Celakovsky, Kanitz, Kerner, Willkomm; *Belgium*, Crépin, Durand; *Sweden*, Fries, Wittrock; *Portugal*, Henriques; *Spain*, Lara; *Denmark*, Lange; *Netherlands*, Suringar; *Australia*, Von Mueller; *United States*, Britton, Coulter, Greene.

BY TREATING SPECIMENS of Spirogyra from which the starch had been entirely removed with substances which readily break up into simpler constituents, of which formic aldehyde is one, Herr T. Bokorny showed that these plants have the power of separating formic aldehyde from the nutrient solution, and then converting it into starch. This appears to furnish argument in favor of the view that formic aldehyde is the substance first formed in the production of carbohydrates from the carbon dioxide of the atmosphere.—*Jour. Roy. Micr. Soc.*, Feb.

NUMBERS 76—79 of Engler and Prantl's *Die natürlichen Pflanzenfamilien* have just been distributed. No. 76 contains a continuation of the

[1] Berichte d. deutschen bot. Gesellschaft, x, 441 (1893).
[2] See Pflüger, in his Archiv f. d. ges. Physiologie, x.
[3] Berichte d. deutschen bot. Gesells. x. 451.

first volume, and presents Myxogasteres, Fungi, and Chytridineae, by J. Schröter. No. 77 contains another installment of the Leguminosae, by P. Taubert; No. 78 contains the Cyrillaceae, by E. Gilg, the Aquifoliaceae, by M. Kronfeld, and the Celastraceae, by Th. Lösener; No. 79 contains the Chenopodiaceae, by G. Volkens. In all these parts the same splendid typography and engraving continues. The American genera of the groups above mentioned stand very much as our monographers have left them.

By a series of experiments extending at intervals over three years made with the intermittent klinostat (a klinostat so modified as to make a partial rotation at regular intervals, remaining stationary in the mean time) Professor Francis Darwin and Miss Pertz have shown that rhythmic curvatures in plants may be artificially induced by exposing shoots to alternate and opposite stimuli of a geotropic or heliotropic nature. When a plant had come to be in a thoroughly rhythmic state they found it possible to prophesy to a minnte at what time the reversal of curvature would take place. These experiments are of great interest in their bearing on periodic movements.

Dr. Karl Gœbel calls attention in *Annals of Botany*, vi. 355, and also in *Flora*, to the location of the sexual organs in Buxbaumia, in which the single antheridium is borne on the protonema itself, with only the formation of a single involucral leaf, so that alone this structure would pass for an alga; while the archegonia are borne on a very rudimentary stem with several involucral leaves. Thus Buxbaumia comes very near to the theoretical idea of the simplest moss, which looks upon the protonema as the primitive oophyte, and conceives the leafy stem to be a specialized archegoniophore which gradually came into prominence as an advantageous host of the sporophyte.

M. Ph. van Tieghem, in *Journal de Botanique*. (March 1) discusses the classification of Basidiomycetes. He recognizes nine co-ordinate families in the group, as follows: Lycoperdaceae, Agaricaceae, Tilletieae, Tremelleae, Tylostomeae, Ecchyneae, Auricularieae, Pucciniaceae, and Ustilageae. The first family contains five tribes, the second nine, the eighth ten, and all the rest are represented by a single tribe. The Lycoperdaceae contain Gastromycetes of authors, excepting Tylostomeae and Ecchyneae, which are raised to family rank. The Agaricaceae contain the Hymenomycetes of authors, and also the Dacryomycetes usually included under the Tremelleae.

Mr. Thomas Morong, has some interesting notes on Orchids in the *Bulletin of the Torrey Botanical Club* (February). A new species of Listera from Hudson Bay Territory is described; attention is called to the fact that many orchids are capable of self-fertilization; and certain necessary changes in nomenclature are pointed out. According to our recent agreement in reference to date, *Calopogon* R. Br. should be replaced by *Cathea* Salisb.; *Spiranthes* Richard by *Gyrostachys* Persoon; *Goodyera* R. Br. by *Peramium* Salisb.; and *Mycrostylis* Nutt. by *Achroanthes* Raf. In a note in the March number, however, he corrects his change of Colopogon to Cathea and says that *Limodorum* is entitled to use.

Among recent bulletins from the Experiment Stations containing botanical matters are the following: "Oat smut" by L. R. Jones (Vt., No. 6); "Can peach rot be controlled by spraying?" by F. D. Chester (Del., No. 19); Common fungous diseases and their treatment" by W. C. Sturgis (Conn., No. 115); "Preventive treatment for apple scab, downy mildew and brown rot of the grape, potato blight and the smut of wheat and oats" by E. S. Goff (Wis., No. 34); "Black rot of the grape" by R. H. Price (Texas, No. 23). Bulletin No. 49 of the Cornell Station upon "Sundry investigations of the year" contains a short article on "Golden rod weeds" by A. N. Prentiss, two fungous diseases are described by G. F. Atkinson, and L. H. Bailey writes about a new maize and some egg-plant crosses.

There are two stations in Italy for the economic investigation of plant diseases, as we learn from an article by L. Paperelli, in the *Experiment Station Record* (iv, 233). One is the royal Station and Laboratory of Cryptogamic Botany at Pavia, established in 1871 in connection with the Botanical Institute of the Royal University. The director is Prof. G. Briosi, who has a special assistant for the station work. The income is about $2,000. The laboratory is also used for students in connection with the University. The other is the Royal Station of Vegetable Pathology at Rome, established in 1887. The director is Prof. G. Cuboni, who has two assistants. The income in 1891-'92 was $2,600. They are required to investigate the nature and cause of diseases, test and provide remedies, and disseminate information by lectures and publications.

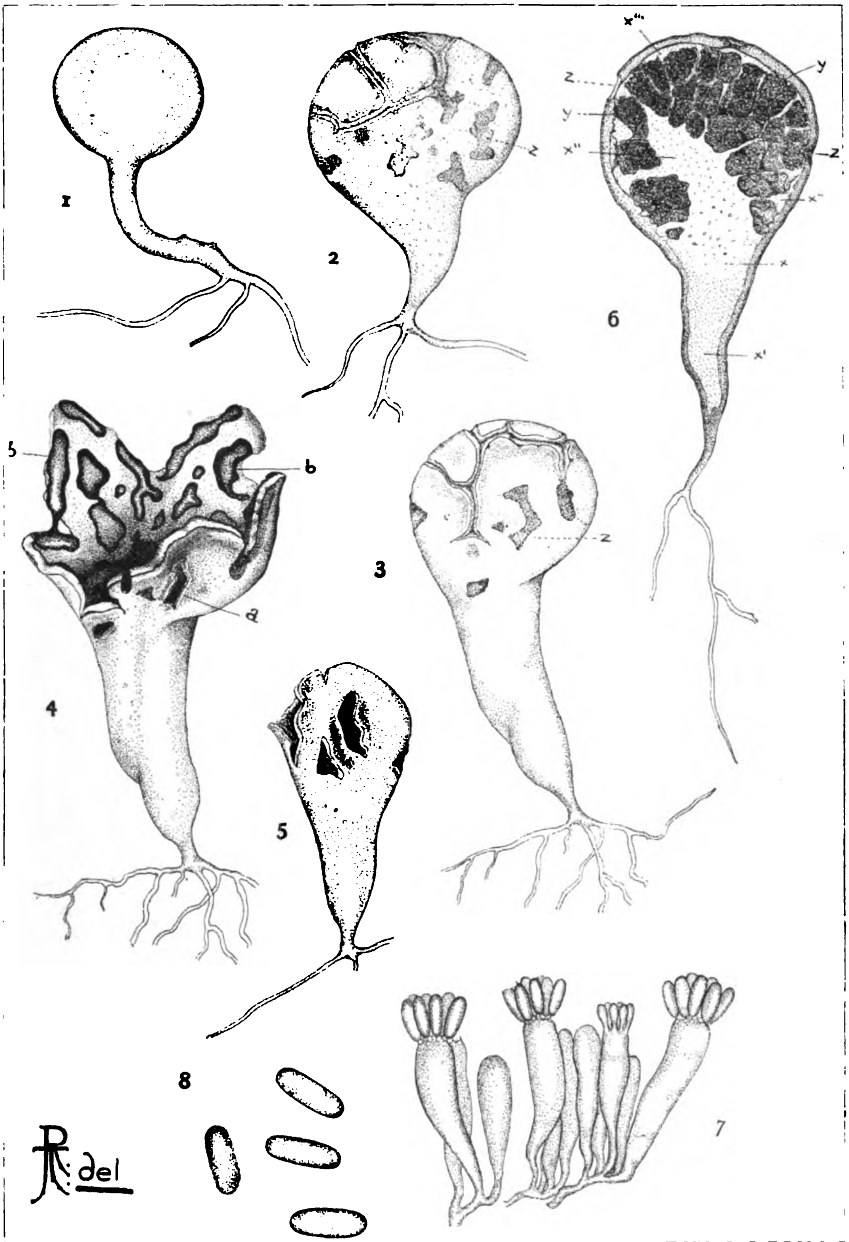
Two papers on carnation diseases were read before the American Carnation Society at its annual session in Pittsburg during the last week in February, both of which are printed with many illustrations in the *American Florist* for Feb. 23d. One was by Prof. Geo. F. Atkinson, of Cornell University, who treated of rust (Uromyces caryophyllinus), spot (Septoria Dianthi), anthracnose. (Volutella sp.), rosette (Fusarium sp.?), and fairy ring spot (Heterosporium echinulatum). The development of the fungi producing these diseases is very fully described, including the behavior of part of them in gelatine culture. Illustrations are also given of a Cladosporium and a Botrytis which injure carnations. The other paper was by Prof. B. D. Halsted, of Rutgers College, describing spot, anthracnose, leaf mold (Cladosporium sp.), and a bacterial disease. A considerable part of the paper was devoted to remedies and means of controlling the several diseases.

The Proceedings of the American Association for the Advancement of Science for the meeting at Rochester, August, 1892, has lately been distributed. It is a volume of 380 pages mostly devoted to the addresses of the officers, reports of committees, and abstracts of papers read. There are twenty-four botanical papers, represented by abstracts of about half a page each, and fifteen titles without even abstracts. There are several biological articles of as much interest to botanists as to those to whom they were especially addressed. Of these may be mentioned *Heredity of acquired characters*, by Manly Miles; *Comparative physiology of respiration*, by Simon H. Gage, and *Micro-organisms of the soil*, by Alfred Springer, the two latter being vice-presidential

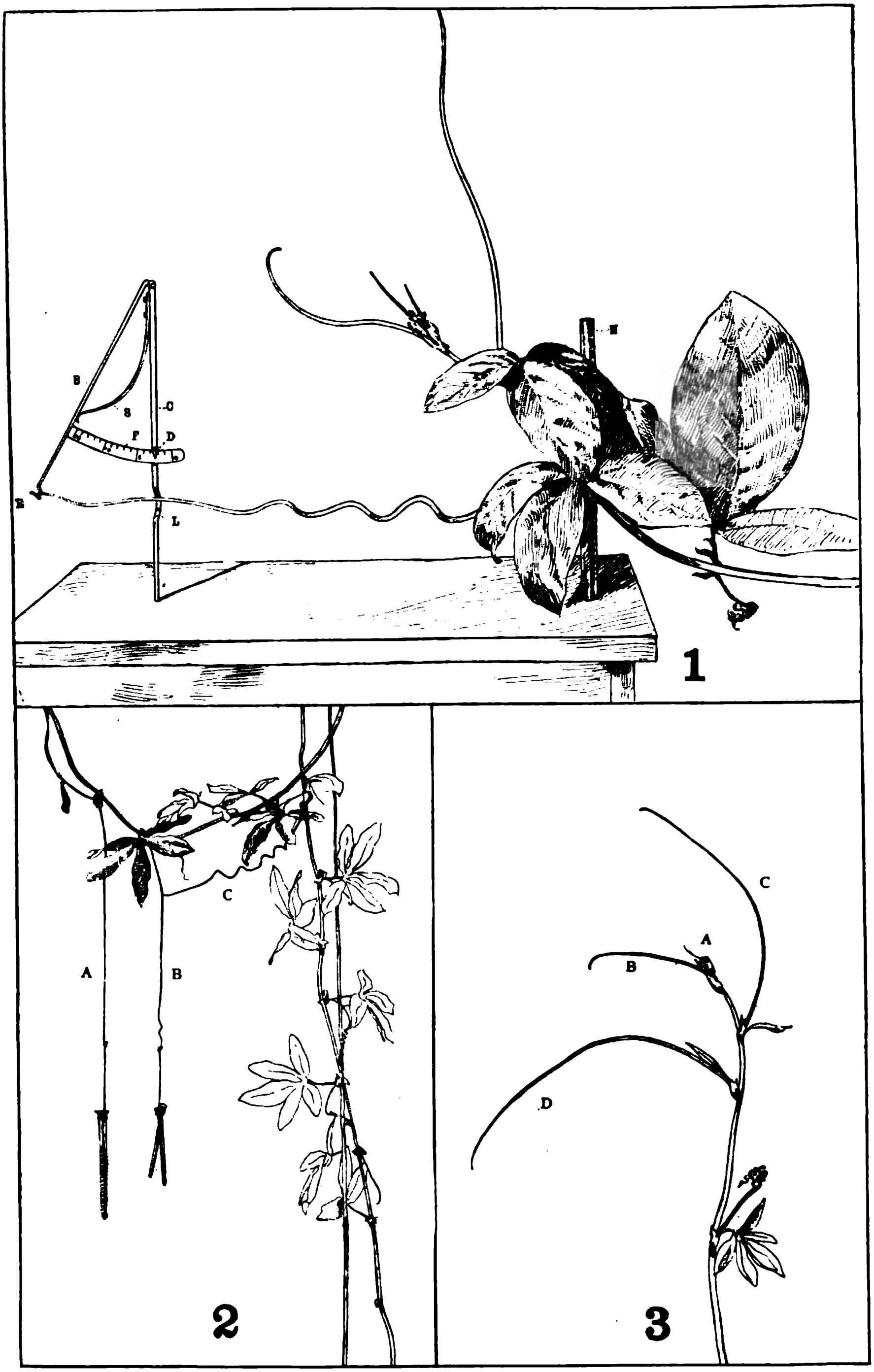
addresses. The address of the retiring president, Albert B. Prescott upon *The immediate work in chemical science* is filled with important suggestions and almost as applicable to botany as to chemistry.

IN A LONG paper in the March number of the *Annals of Botany* Dr. D. H. Scott and Mr. George Brebner discuss the secondary tissues in three genera of the shrubby monocots, namely, *Yucca*, *Dracæna*, and *Aristea*. They first reinvestigated the vexed question regarding the mode of origin and growth of the tracheides of Yucca and Dracæna. This question is mainly concerned with the point as to whether these secondary tracheides arise from the growth of a single cell, which consequently would have to push its way between other already formed cells much as the hypha of a fungus might, or whether the tracheides are formed by the fusion of several cells standing end to end. These investigators fully agree with the researches of Krabbe and Röseler, concluding that "the tracheides are formed by longitudinal growth only, each tracheide arising from a single cell, which may grow to thirty to forty times its original length, but remains uninucleate throughout its whole development." Further: "As the secondary tracheides are formed in a region which has ceased to grow in length, their development is entirely by sliding growth. . . . There can be no doubt that the development of the tracheides in the primary bundles is similar, but as the latter are formed in a region which is still lengthening as a whole a proportionately smaller amount of sliding growth is involved.

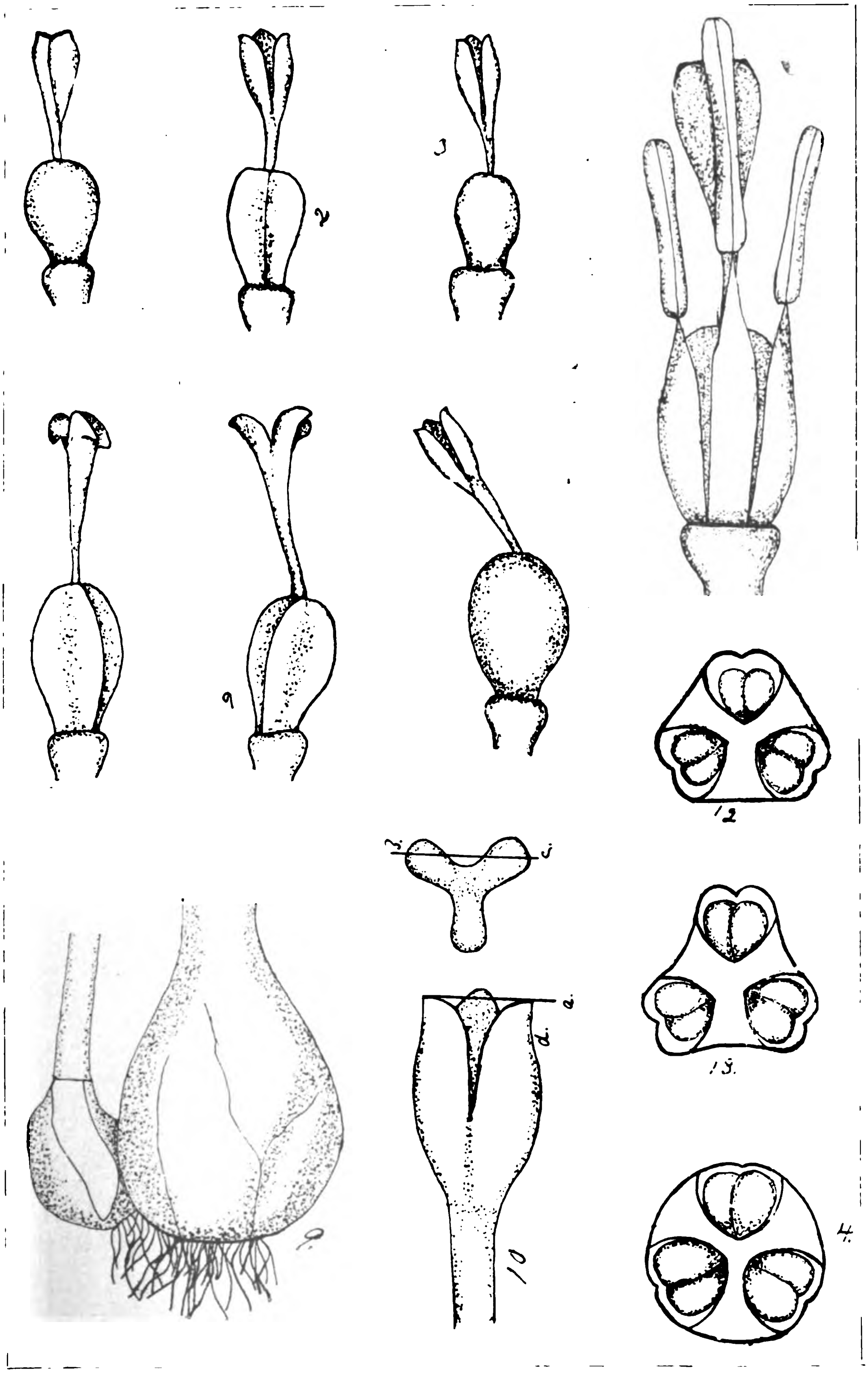
The studies of these gentlemen on the structure of *Aristea corymbosa*, one of the four known shrubby members of the great order Irideæ, have established the fact that this species "in common no doubt with the few other shrubby species of Irideæ, forms an indefinite amount of secondary tissue by means of cambium which continues active during the whole life of the plant. The tissue formed centrifugally, on the inner side of the cambium, consists of secondary concentric bundles, imbedded in ground tissue; on the outer side of the cambium a large amount of secondary cortex is formed. The latter is wholly parenchymatous." The authors point out that there is a remarkable agreement between the three groups of monocots in which secondary thickening occurs, and they hold that this peculiarity has arisen independently in each of the three. They add: "It is very probable that the first origin of secondary growth may be taking place in some of the monocotyledons at the present day, just as we find medullary bundles appearing in certain dicotyledons as an individual peculiarity."



THAXTER on PHALLOGASTER SACCATUS.



MacDOUGAL on PASSIFLORA.



MEADS on ERYTHRONIUM.

BOTANICAL GAZETTE

MAY, 1893.

Contribution to the biology of theorganism causing leguminous tubercles.

GEO. F. ATKINSON.

WITH PLATES XII—XV.

The study of the tubercles of the Leguminosæ involves several fields of investigation. One is concerned with the economic phases of the subject, the acquisition of nitrogen from the air by plants and the enriching of the soil by decay of the plants or by the setting free of nitrogenous substances, upon the decay of the tubercles, which have been fixed by the aid of certain organisms within the tubercle. This phase of the subject is of such practical importance that it has been treated of very widely in agricultural papers and is in a general way better known than the other aspects of the subject.

Another field of investigation is a chemico-physiological one and relates to the question of the method of acquisition of nitrogen by plants, and the physiological processes involved.

Still another field of investigation is the biology of the subject. This is concerned primarily with the induction of facts relating to the morphology, development and kinship of the lowly organism, to the structural features of the tubercles and the relation of the two symbionts. It is beyond the scope of the present paper to treat of the economic and chemico-physiological aspects of the subject. The discussion will be confined mainly to the biology of the organism, since this part of the subject is the least understood and there exist so many conflicting views concerning it. The structure and development of the tubercle is better understood and will be referred to only incidentally as is found necessary in dealing with the relations of the two organisms.

Original investigations.

Four years ago while engaged upon a study of the nematode root-galls[1] of various cultivated plants, I was led to investigate with some care the morphology and anatomy of the leguminous tubercles and their contents in order primarily to discover differential characters which could easily form the basis for the accurate separation of the tubercles from nematode galls which frequently occur on the same roots. A brief résumé of the results of the leading investigations up to that time was presented along with the results of the root-gall study.

The subject became to me so fascinating at that time that during the seasons of 1891 and 1892 considerable attention was given to further personal examination of the subject, and to familiarizing myself with the literature relating to the morphology of the organism. It soon became apparent that while nearly all investigators agreed in regard to certain morphological phenomena presented in connection with the anatomy of the tubercles, several conflicting interpretations were given of them, and nearly as many views were entertained respecting the nature of the organism. For this reason, and also because no American observations had been recorded at that time, I was led to undertake some personal investigations of the biology of the organism. During the winter of 1891-2, therefore, preparations were made for this work. It has seemed best to first present here the results of my own study, and to follow this with a historical résumé and a comparison of the conclusions reached elsewhere.

The tubercles are quite prominent lateral outgrowths of the roots and present varied forms, the types of which are associated with different groups of the Leguminosæ, though the limits of these groups do not correspond in all cases with those of genera.

In *Vicia sativa*, from the tubercles of which pure cultures of the organisms were obtained, they are digitate, and either simple or forked di- or tri-chotomously. They vary in length from a size equal to their diameter to 4^{mm} to 7^{mm}. Plate XII illustrates several roots of *Vicia sativa* reproduced from photographs. It will be observed that the tubercles stand nearly at

[1] A preliminary report upon the life history and metamorphoses of a root-gall nematode, *Heterodera radicicola* (Greeff) Müll. and the injuries caused by it upon the roots of various plants. Science Contrib. Vol. I. no. 1. Ala. Agr. Exp. Station, Dec. 1889.

right angles to the roots and that there is no taxic law governing their position on the roots. On some of the plants they are crowded on the root near the union with the stem. In such cases infection took place profusely at a very young stage of the seedling. On other plants very few tubercles are found near the union of the root and stem, but they are widely distributed over the root system. The roots illustrated in plate XII show this variation well.

When the tubercles are young or growing rapidly they are of a delicate flesh color, presenting a mealy aspect from numerous cells of the cortical parenchyma which are being pushed apart from their union by the rapidly growing meristematic tissue of the tubercle. When the tubercles have attained some size and age the older portion presents a light brown color in contrast with the flesh colored distal portion. Some of the other type forms of the tubercles are represented in *Medicago denticulata*, *Dolichos Sinensis*, and *Trifolium.*

In *Medicago denticulata* they are remarkable both for their size and compact botryose ramification, attaining a diameter frequently of 1^{cm} to 1.5^{cm} and bearing a striking resemblance in external appearance to the root-galls of *Alnus* which however are produced by an entirely different fungus of the genus *Frankia*, as described by Brunchorst[2], Möller[3], and the writer[4]. In *Dolichos Sinensis* the tubercles are irregularly rotund bodies. In *Trifolium procumbens*, *Carolinianum*, and other species they are cylindrical-clavate.

Vicia sativa matures its seed during the months of May and June in central Alabama[4a]. During the sunny part of dry days the mature pods by unequal contraction are suddenly split apart and the seed cast to a considerable distance. During the summer, autumn, and early winter months the seeds are gradually buried in the soil, so that during mild weather in January and February they germinate and grow so luxuriantly as to afford in some cases valuable winter grazing. The temperature of the soil at this time is sufficiently warm to permit the growth of the tubercle organism, and at an early stage

[2] Ueber einige Wurzelanschwellungen, besonders diejenigen von Alnus und den Elæagnaceen. Unters. Bot. Inst. Tübingen. II. 151.

[3] Beitrag zur Kenntniss der *Frankia subtilis* Brunchorst. Ber.d.deutsch.bot. Gesellsch. VIII (1890). 215-224.

[4] The genus Frankia in the United States. Bulletin Torrey Bot. Club. XIX. June, 1892.

[4a] When this study was begun the writer was connected with the Ala. Polytechnic Institute, Auburn, Ala.

it is easy to find numerous rapidly growing and fresh tubercles. The temperature of the soil is sufficiently low, however, to retard the growth of many soil organisms, so that the outer surfaces of the tubercles do not contain such numbers of bacteria as are met with in the warm days of late spring. The early season then is the more favorable for the separation of the organism.

As soon as the plants had attained sufficient size to gather a small quantity of the vines an infusion was made and added to agar-agar peptone broth to afford a suitable medium in which to transplant the organism.

Method of obtaining pure cultures.

To separate the organism without contamination young but fair sized tubercles were selected. These were washed carefully and finally rinsed in distilled water and allowed to drain until the surface was not wet. A razor was then heated, not to redness, but to such a degree as would probably kill all adherent germs. A small segment was then removed from the end of the tubercle with a quick stroke of the razor so that the heat would not kill the organisms in the tubercle. As the razor was passing through the back was lifted during the stroke in order to lessen the possibility of dragging germs from the outside into the center. Then a flamed, double, sharp-pointed platinum needle was thrust into the cut end, twisted part way around, withdrawn, and with this a puncture was made in the vetch agar in culture tubes. The first transplantings were made in March, 1892, ten or twelve culture tubes being inoculated. Some of these proved to be contaminated in a few days, possessing common forms of *Bacillus*, *Micrococcus* and *Bacterium*. Others showed no evidence of growth before eight to ten days, when there appeared in a few of the culture tubes a small whitish, glistening, pearly colony at the surface of the point of inoculation. In a week more this growth had increased, having a surface extent of 2^{mm} to 3^{mm} and presented a slight convexity of surface. The growth did not extend perceptibly to more than 2^{mm} to 3^{mm} deep in the medium, but at a subsequent time spread over a greater area upon the surface. The slow growth of the organism in the artificial medium caused it to be looked on with suspicion. When the growth had attained such proportions that a small quantity could be removed without destroying the entire colony, an examination was made of the organism.

The individuals are held rather firmly together by a viscid excretion so that portions of the mass appeared "stringy" as the needle was lifted from it. They are very minute yet quite characteristic in form, and as they appeared in artificial culture are easily distinguishable from other organisms. In general appearance many of the individuals resemble some yeast, or low torula forms, yet they differ in shape and in being much smaller than any known yeast. Although so small the individuals vary greatly in size and present remarkable variations also in form. In size they vary from 0.2μ to 2μ or 3μ, and in form from a triangular outline to oval, elliptical, oblong, torulose, or variously forked and amœboid forms, as represented in figures 11 and 12 of plate XIV. A nearly homogeneous protoplasm occupies by far the larger and more central portion of the organism, while the granular protoplasm is near the periphery, but usually collected or bunched at certain points near the interior surface of the wall, these being connected by thinner sheets or threads of similar protoplasm. After some study of the different forms and observations in cell cultures it was found that these masses of granular protoplasm are almost invariably located at the growing points of the individuals, and it would be quite possible within certain limits, perhaps, from a rather simple individual to determine the more complex form it would assume at a later stage. Figures 11 and 12 represent clearly the relation of the granular protoplasm to the growing points of the individual. In figure 11*a* the individual is of an amœboid form, and the granular protoplasm bunched near the center of the figure represents in reality a downward growing process at this point, which could easily be seen by changing the focus of the microscope.

In cell cultures which were started by inoculating melted vetch agar, after a period of incubation of five to ten days there appear minute flocculose areas of growth at different points in the medium. These increase in extent until colonies of varying size occupy the medium.

The same organism has also been obtained in cell cultures of vetch agar by transplanting to them a thin section of the inner part of a tubercle, after the cortex had been removed, of course observing aseptic precautions.

In from six weeks to two months the organism was transplanted into fresh culture media to prevent death from lack of nutrition.

Inoculation experiments.

During the month of April, 1892, an experiment was put in progress to determine the relation of this organism to the orientation of the tubercles. Vetch seeds which had been gathered the previous year for this purpose were planted in two different vessels. These vessels contained sand from which the soil had been washed. The sand was saturated with distilled water to which was added a small quantity of kainite and acid phosphate, and the vessels were then steam sterilized two hours a day for three successive days. The sand was so saturated with water that it was covered with a thin layer. This was necessary in order to provide sufficient moisture for the hard dry vetch seed to germinate. After the plants had attained a length of 5^{cm} to 10^{cm}, organisms from the culture tubes of vetch nutrient agar were transplanted to vessel no. 1. An attempt was at first made with a fine needle to inoculate roots at certain points but the quantity of moisture in the sand quickly dispersed the organism over all parts of the surface of the sand. Vessel no. 2 was held as a check. There were from fifteen to twenty plants in each vessel.

During a period of a month the plants in both vessels made slow growth, being kept in a window in the laboratory, and a large bell jar covering both rested upon an uneven surface so that the air would not be kept too moist. At the end of this time a few plants in vessel no. 1 were examined and found to possess several small tubercles each. The tubercles were very much smaller than those developed in nature, as were also the vetch plants, owing probably to the artificial conditions of environment. These tubercles on the plants in vessel no. 1, developed as a result of artificial inoculation, formed the material from which a study of the organism within the tubercle was made. The examination and study of these tubercles and the organism within extended over a month's time, and it was found at the close of this period that only a few of the plants in vessel no. 1 escaped inoculation. In vessel no. 2 not a single tubercle was developed.

In July of the same season a second inoculation experiment was conducted, the vetch plants this time being grown in water culture. Five glass vessels, capacity about one pint, having a rather small neck, were fitted each with a cork which would float on the water when this rose above the neck of the vessel and partly filled the basin formed by the flaring edges.

When the water became low the cork would rest in the neck of the vessel. The corks were perforated to admit the young roots of the vetch seedlings. Mineral fertilizers consisting of acid phosphate and kainite were added to the water and the vessels were then thoroughly sterilized. Vetch seeds were germinated on moist sterilized sand, and when the seedlings were of sufficient size for the young root to reach the water, the plant was placed in the perforation of the cork. Three plants were transferred to each vessel. In a few days when it was assured that the plants were all growing nos. 1 and 4 were inoculated by transplanting with a looped platinum needle a quantity of the organisms from the pure culture to the roots of the seedlings in the perforated cork. This experiment was also successful and though the tubercles were small they were so distinct as to be readily photographed. The entire experiment was then photographed and is represented in plate XV. Two tubercles can be seen in each of jars no. 1 and 4. The checks, nos. 2, 3 and 5 possessed no tubercles. The organisms used in this second inoculation experiment were of the fifth transplanting in the culture tubes. These results would seem to afford pretty conclusive proof that the organism described above from cultures in artificial media the specific microsymbiont of the vetch tubercles.

Mode of infection.

As stated above, the material which formed the basis for the study of the organism in its natural relation to the tubercles was obtained from the inoculated plants in the first experiment, which were grown in sand culture. Roots possessing very young tubercles were mounted in water for microscopic examination of the surface. At the youngest stage examined the tubercles presented only a low convex lateral protuberance of the surface on one side as shown in figure 4 of plate XIII. The root still possessed numerous normal root hairs some of which also occupied the surface of the young tubercle. In many instances at this young stage one of the root hairs presented a very peculiar appearance. This is represented in figure 4, plate XIII, and the same root hair is drawn to a larger scale and from two different points of view in figures 5 and 6. The very tip of the hair is coiled once in a close spiral and the end has undergone further change in shape by being bent in the form of a shepherd's crook or a walking stick. The organism usually enters at the end of the root

hair, and must exert a peculiar and powerful influence in order to bring about this change in form.

Form of the microsymbiont in natural environment.

In the protoplasm of the root hair, which is a more suitable pabulum than the nutrient vetch agar, and also in point of view of economy in nature, the organism does not grow indifferently as to direction but extends straight away down the root hair in its effort to reach the cortical parenchyma of the root. Probably the macrosymbiont also exerts some influence on the direction and definiteness of the growth of the microsymbiont.

In figures 5 and 6 the organism presents the form of a thread or non-septate hypha, in size from one fourth to one third the diameter of the root hair. It describes a somewhat flexuous course and occasionally, as shown near the outer end in figure 6, broadens slightly at places presenting a nodulose appearance. Rarely the organism enters the root hair nearer the proximal end as shown in figure 7. In such cases the end of the root hair is not deformed. The ends of the root hairs frequently become deformed and variously curved from other causes, but when it is due to this organism its presence can quite easily be noted.

The contents of the infecting hypha are homogeneous and the entire thread presents a gleaming aspect which enables one to readily distinguish it from the contents of the root hair.

When the organism has once entered the cortical parenchyma its manner of growth becomes quite different, since it is coming more directly within the arena of its real activity and more directly under the influence of the macrosymbiont. By this time it has already stimulated the root tissues at that point to greater activity and a meristematic growing point arises about it within the cortical parenchyma. Frequently as the hypha passes through the cell walls it first broadens out in the form of a disk over the surface of the wall at this point, the portion of the hypha which passes through the cell wall being very slender, and upon reaching the other side of the wall it again broadens out into a disk. A lateral view presents the appearance shown in figure 8, a section of the young tubercle containing the infecting hypha. This is better shown in figure 9, the cell walls being represented in some cases by a straight transverse line. This does not occur at the passage

of all the cell walls, but it is of very common occurrence. As represented in figure 7 the hypha sometimes enlarges within the center of the cell lumen very near the epidermis. Farther within the tissue of the tubercle the enlargement of the hypha within the cell lumen is of very frequent occurrence.

The surface of these enlarged portions within the cell lumen is usually marked by a number of protuberances in the nature of buds. These buds present various forms, being either spherical, oval, pyriform, clavate, cylindrical or forked. Soon after entering the root the hypha branches. Some of these ramifications continue toward the center of the root until they reach the endodermis, but do not pass beyond. Others take a lateral course, and from these other ramifications extend outward, and as the tubercle grows in length some are directed radially from the axis of the root and grow in an opposite direction from the course pursued by the infecting thread. Thus the entire inner portion of the tubercle is traversed in a labyrinthine fashion by the ramifications of this organism. A portion of the center of the section shown in fig. 8 is more highly magnified and illustrated in detail in fig. 10, plate XIV. It is a very common thing for the hypha in passing the lumen of the cell to approach the nucleus, enlarge and partly surround it, as shown in figure 10. In many cases the nucleus seems to be stimulated so that it becomes larger than the nuclei not in contact with the hypha.

In making the section represented by figure 8, the infecting thread was cut off along with the root hair at the surface face of the tubercle and appeared in an adjacent section. This is mentioned merely to account for the absence of the root hair containing the infecting thread in that figure. These tubercles produced by inoculation in artificial culture were far superior for studying the form of the organism in the tubercle to those developed in the soil. The food and conditions for growth for the vetch being inferior to those in its natural environment, the protoplasm was not developed so profusely in the tubercle and therefore presented a more favorable opportunity for staining and definition. Violet dahlia, first suggested by Laurent[5] for the tubercle hyphæ, was used in making the preparations.

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[5]Recherches sur les nodosités radicles. Ann. de l'Inst. Pasteur, v (1891). 105–139.

While the organism does not pass the endodermis, its influence upon the hypertrophy of the tissues extends to the endodermis and the tissue of the central cylinder on that side.

(*To be continued.*)

Cornell University.

The genus Corallorhiza.

M. B. THOMAS.

WITH PLATES XVI AND XVII.

The genus Corallorhiza contains twelve recognized and well defined species with widely varying habitat, being found in Europe, Asia, United States and Mexico.

Four species are found in Northern United States; *Corallorhiza innata* R. Brown, *C. odontorhiza* Nutt., *C. multiflora* Nutt. and *C. striata* Lindl. Of these C. multiflora has the widest range and is the one found in greatest abundance.

The parts above ground have been quite thoroughly studied and the structure is generally well understood, but the parts below ground certainly afford an opportunity for much profitable investigation. The plants of the genus are brownish or yellowish herbs, without chlorophyll, except a little late in life, and in C. multiflora they often reach the height of eighteen inches.

The parts underground are usually described as being "much branched and toothed coral-like root-stocks (probably root parasitic) sending up a simple scape, with sheath in place of leaves, and bearing a raceme of rather small, dull-colored flowers."[1] From the rather striking characters of the stem and flowers it might be expected that the plant would exhibit several marked deviations from the regular phenomena of growth and development, and such is indeed the case. The coralline root-stock which the plant possesses has many variations from the regular type of the underground stem of monocotyledonous plants. The vascular system is represented by somewhat modified collateral bundles which are confined to the center of the stem; these are small and usually quite rudimentary. The whole vascular system is

[1] Gray's Manual, 6th edition.

surrounded by a sheath of collenchyma which gives the fibro-vascular tissues somewhat the appearance of the radial bundles of roots. The arrangement of bundles inside the sheath is as one might expect, usually irregular, but in each individual bundle the phloem occupies the peripheral side.

At the apex of the stem we find about the normal arrangement of parts. The leaves originate near the apex as lateral outgrowths in acropetal order. The primary meristem of the growing point is very active and several immature leaves with those just forming cover the apex.

The tissue of the leaf is perfectly continuous with that of the stem. The foliar bundles are very small and merely pass up to the base of the leaf, which undergoes no differentiation but simply breaks away and there remains a ring or scar in its place on the stem. In the depressions between these rings are found papillæ, which, on the average, are 0.2^{mm} high, and 0.6^{mm} in diameter. On these are borne the trichomes, which are often longer than the height of the papillæ. By means of these papillæ the root may cling tenaciously to any substance with which it may be in contact. Trichomes are often developed on the portions of the leaf-scars that may remain attached to the stem. They are quite large, thin walled, and contain protoplasm with a very large nucleus.

The plant is said to be a parasite, but the weight of evidence seems to strongly contradict such a supposition. Although by means of these trichomes the plant may cling to the roots of other plants, yet repeated search has failed to show any organic connection with them. The epidermis of the root-stock is much broken up by the numerous leaf scars and papillæ but it presents the ordinary characters of a true epidermis. The cortex is of the usual nature and contains many large cells with raphides. It may be possible that the plant does derive some of its nourishment from the roots of other plants to which it clings by means of its papillæ with their trichomes, yet these papillæ are found equally on all parts of the root-stock, and that too on plants which are in no way connected with any other living plant; while those grown in a jar of ordinary soil, free from the roots of all other plants, thrive equally well with those in the woods.

The question at once presents itself, how does the plant elaborate its fluid without the intervention of chlorophyll, especially since in the autumn there is a ring of cortical tissue about the fibro-vascular system the cells of which are filled

with starch, while the remainder of the cortex toward the epidermis contains a considerable quantity of it.

When first studying these stems it was observed that the cell contents of the cortical tissue stained a *dark* purple with hæmatoxylin and often a brownish hue was secured. As this did not represent the usual reaction, it seemed that something extraordinary existed in the cells, and upon further examination it was seen that their cell contents consisted of a small mass of protoplasm completely surrounded and permeated by a great number of septate hyphal threads and these were often traced to similar ones outside of the stem. The latter were somewhat larger and always presented a much denser structure. At first it seemed that the threads might be accidental and due to the presence of some parasite that had attacked the individual plant, but later they were found in the stems of plants obtained from various parts of the country.

The hyphæ are confined to a certain region of the stem and are seldom found within 3–4^{mm} of the tip. The cells nearest the tip, in which they first appear, contain but a few, and it is here that their structure can be best studied. Farther back from the tip the threads increase in abundance in the cells and become very much smaller until they seem to be finally absorbed by the cell protoplasm. The whole assemblage then assumes a granular character and forms with the original cell contents a homogeneous mass. The action of the nucleus is very certain as it responds to the presence of these threads by enlarging, and thus showing an increase in the activity of the cell. Very few of the threads are ever found in the epidermal layer, but they pass through this into the cortex beneath. The few that are in the epidermal tissue partake of the nature of those outside, while just beneath a marked difference is seen.

With a magnification of 2,000 diameters the threads are seen to be a cylindrical tube with walls of a distinctly laminated structure, septate and the outer surface in many cases covered with protuberances. The central cavity of the thread is filled with filamentous masses of protoplasm of a granular character. The hyphæ branch freely and often seem to radiate from a common center which may be the nucleus of the cell.

The cell walls are pierced readily and the threads can be traced through several rows of cells. In proportion to the number of hyphæ present the walls are little punctured as the

great mass of threads is confined to the interior of the cell and they are seldom found in the intercellular spaces. The tissue of the stem is most thoroughly permeated with these hyphæ, and every cell outside of a narrow zone around the plerome, which so often contains starch, and back 2–3^{mm} from the tip, is filled with them. The tissue exhibits nothing that would in any way seem to indicate that the presence of these hyphæ was anything other than beneficial and there can be no doubt of there existing a true symbiotic relation.

The large amount of starch often found in the rootstock cannot be due to the decomposition of CO_2, for chlorophyll is wanting; but it is a derivative of those chemical compounds which have been dissolved and taken up by the hyphæ from the remains of dead plants. The ash constituents and some of the nitrogen compounds may be taken up from the soil by the trichomes and the nitrogen used in the formation of proteid substances for the plant, while the trichomes in contact with old leaves and other humus substances no doubt secrete a ferment and absorb the products which are in solution. This action with the symbiotic relation existing in the plant would give it two methods of obtaining plant food. From the structure of the plant and the abundance of the hyphæ the latter condition must furnish it its greatest source of supply.

Instead of being a root parasite, as has been supposed, the plant depends chiefly on the symbiotic condition for its food and this is taken by the hyphæ from the decaying vegetable matter about. If the plant was once a true parasite the roots have degenerated and finally disappeared, for no roots are found on the plant. This condition exists in an equal degree in all of the species of Corallorhiza yet examined.

It should be stated, however, that hyphæ have been found in the roots of all of our North American Orchidaceæ yet examined (more than forty species), but only in a very limited degree, apparently not enough to materially affect the normal conditions of growth and development; although some varying conditions due to the presence of these relations have been observed, which are constant through the whole group. Endotrophic mycorhiza that pass their whole life course in the part of the plant below ground do no doubt exist in all of the Orchidaceæ. The genus Corallorhiza, in the abundance of this condition, is far removed from the other members of this order.

It is not necessary to give a complete bibliography of the work done on the subject of symbiosis. References to the more important articles can be found in the paper of A. Schneider.[2] The principal papers of B. Frank, who has no doubt done more than any other observer on this subject, can be found in the Berichte der deutschen botanischen Gesellschaft, 1890, 1891, and 1892.

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EXPLANATION OF PLATES XVI AND XVII.

Figs. 1, 2. Base of aerial and subterranean stems of *Corallorhiza innata* R. Br.

Figs. 3–9. From *Corallorhiza multiflora* Nutt.

Fig. 3. Base of aerial and subterranean stems. Fig. 4. Longisection of root-stock; *a*, old leaf not yet broken away; *b*, *c*, remains of leaves that have broken away; *d*, papilla with trichomes, *g*; *e*, axial bundle; *f*, large cells containing raphides. × 480. Fig. 5. Cells of cortical tissue, with hyphæ, taken from the tip of the stem where they contain but few hyphæ; *a*, enlarged nucleus. Fig. 6. One of the rudimentary bundles of the stem; *a*, general bundle sheath; *b*, xylem; *c*, phloem; *d*, fundamental tissue. × 750 Fig. 7. Remains of a leaf, *a*, with trichomes, *b*. × 750. Fig. 8. Papilla, *a*, with trichomes, *b*. × 750. Fig. 9. Transection of root-stock; *a*, papilla with trichomes; *b*, cell with raphides; *c*, general bundle sheath; *d*, collateral fibro-vascular bundle with an unusually regular arrangement. × 480.

George Vasey: a biographical sketch.

WM. M. CANBY AND J. N. ROSE.[1]

WITH PORTRAIT—PLATE XVIII.

On the first of April, 1872, Dr. George Vasey was appointed Botanist to the Department of Agriculture. For twenty-one years he continuously held this position with credit to himself as well as to the advantage and satisfaction of the government and of his botanical confreres. The life of one who could do this during this time of great botanical activity and advancement must present interesting points to all who are engaged in the study of botany; and it is to satisfy this interest that these notes are written.

[2] Bull. Torr. Bot. Club, XIX, 216.

[1] It is proper to state here that Dr. Vasey had requested Mr. Canby to prepare a sketch of his life and the Editors of the GAZETTE not knowing of this request asked me to gather together what data I could regarding his life. At Mr. Canby's suggestion this article is published jointly as it avoids much duplication. My relations with Dr. Vasey, while most intimate, only extend back to 1888, whereas Mr. Canby has enjoyed an acquaintanceship and correspondence of more than 30 years.—J. N. R.

It will surprise many to learn that George Vasey was not a native of this country. He was born near Scarborough, England, on the twenty-eighth of February, 1822. In 1823 his parents came to this country and settled at Oriskany, Oneida County, New York, not far from the birthplace of Asa Gray who was then a lad at school. He was the fourth of ten children; and his father, a steady, excellent man, probably did the best he could when he provided him schooling up to the age of twelve. He had been, however, a good scholar and by that time had advanced sufficiently to have acquired some knowledge of algebra and a good foundation in Latin. He now became employed in a store as clerk, in which occupation he continued for several years at Oriskany and the neighboring village of Pleasant Valley. When between twelve and thirteen, he became interested in the study of botany by means of Mrs. Lincoln's "Elements of Botany," a little book well known to the older botanists of the country. Not having the means to purchase this *he copied it entire.* This interest in botany, so early manifested, was throughout his whole life his one great passion. His first meeting with a fellow-botanist is best told in his own words. "I remember well that one day as I was standing in the doorway of the store, I saw a gentleman approaching who stooped down and plucked a flower from the sidewalk. Coming to where I stood he held up the plant and asked me if I knew the name of it. I replied, 'Yes, it is a buttercup.' 'Well,' said he, 'do you know its botanical name'? 'Yes,' I replied, 'it is Ranunculus acris.' This was probably more than he had expected. We entered the store and he talked with me to ascertain how much I knew of botany. This stranger was Dr. P. D. Knieskern, a German physician, a fine scholar, and one of the foremost botanists of that day. He invited me to visit him, which I frequently did and, as I had considerable leisure early in the morning, I soon began to collect and preserve specimens of the plants of the vicinity and finally made frequent trips with the Doctor until I became well acquainted with the flora of the region. Through him I was led into correspondence with Dr. John Torrey and Dr. Asa Gray. I became much interested in the genus Carex which was largely represented in Oneida County and collected extensively, furnishing specimens to Prof. Chester Dewey of Rochester, Dr. Torrey, and especially to Mr. John Carey, then of New York, who afterward prepared the article on the genus Carex for an early

edition of Dr. Gray's Manual. I should also add the name of Dr. H. P. Sartwell of Penn Yan, New York, with whom I made large exchanges. Ultimately my correspondents included also Mr. S. T. Olney of Rhode Island and Prof. Daniel C. Eaton of New Haven, Conn."

When twenty-one years of age, having already graduated at Oneida Institute, he decided to study medicine and for this purpose attended three courses of lectures at the Berkshire Medical Institute, at Pittsfield, Mass., from which he graduated in 1846. While doing this he was obliged to support himself by teaching school. It was during this time that he first made the personal acquaintance of Prof. Dewey, at that time the leading caricographer of the country. Immediately after graduation he spent a few weeks at the College of Physicians and Surgeons, in New York City. It was at this time that he had the advantage of personally knowing the two preeminent botanists of America, Doctors John Torrey and Asa Gray, and from this time they were his life-long friends. About Christmas of this year he married Miss Scott, of Oriskany, and settled at Dexter, New York, where he commenced the practice of his profession. In 1848 he removed with his wife and child to Illinois, where, at Elgin and Ringwood, he spent eighteen years of his professional life. Very early in 1866 his wife's feeble health compelled him to seek the milder climate of southern Illinois, where, however, she soon died, and he did not long remain. Throughout all these years, first in the rich botanical region of central New York, and afterward almost throughout the prairies of Illinois, he had continued the study of his favorite science, making those large and useful collections which have so enriched the older herbaria of our country, and extending his botanical correspondence until it included all the active workers in the science. From the late Dr. Engelmann, especially, he received much aid, and he also came in pleasant contact with a number of active young botanists, among whom were the excellent Mr. Bebb, Major J. W. Powell, now head of the U. S. Geological Survey, Mr. H. N. Patterson and Mr. S. A. Forbes. These gentlemen, with others, such especially as Dr. J. A. Sewall and Prof. C. D. Wilber, were instrumental with him in forming the Illinois Natural History Society, of which Dr. Vasey was made President.

Toward the close of 1867 he was again happily married. His second wife was the widow of surgeon John W. Cameron,

and daughter of Dr. Isaac Barber, of New York. Soon after he met with a crushing financial disaster, largely dependent upon an imperfect title to his property. It was just at this time that Major Powell was organizing his Colorado Expedition for 1868, and he desired to have Dr. Vasey accompany him as botanist. The devotion of Mrs. Vasey, who took entire charge of his young family and of his entangled financial affairs, enabled him to accept this tempting offer. The expedition did not get under way until June, 1868. By the third of July it had reached Cheyenne and he had already collected one hundred and fifty species. On the twenty-first he wrote enthusiastically of his prospects and of the country, speaking of Denver as a "marvel of a place," having "a population of five or six thousand and many good brick business houses!" He returned in December with a splendid collection which has enriched and enlarged several of the best herbaria of the country. He had now wholly given himself up to botanical pursuits. For a year he was associated with Professor Riley in the editorship of the "Entomologist and Botanist," published at St. Louis, and was also curator of the Natural History Museum in the State Normal University of Illinois, which position he resigned to become the Botanist of the Department of Agriculture and Curator of the U. S. National Herbarium, under the Smithsonian Institution. He received this appointment on the recommendation of Dr. Gray and Prof. Henry. When he assumed these duties, the Herbarium, while containing most valuable material, was in poor condition and of little use. Under Dr. Vasey's wise and energetic administration it has become of vast extent and of prime importance. Overcoming by patient effort the lack of appreciation of those in high office who thought it a waste of time and money to advance the sciences which wait upon and promote true agriculture, he finally obtained adequate means to make his division one of the most active and useful in the Department. His first work of general interest was the collection of the woods of American forest-trees made for the Centennial Exposition in Philadelphia. It was only after much solicitation and some difficulty that he obtained a small appropriation for this purpose. This collection contained good specimens of most of the woods of our country, each specimen being accompanied by one or more herbarium sheets, showing flowers, fruits and leaves. It was a valuable

and instructive exhibit and paved the way for a better study and increased knowledge of the forest wealth, with which our country has been so richly blessed and which our people have so wantonly wasted.

But his crowning work was undoubtedly the building up of the great herbarium. In it are preserved the specimens collected in the various government surveys, and to these are added a vast number obtained by exchange and purchase, by gift from foreign governments and by collections from the remoter regions of the United States and Mexico made by the special collectors of the division. The collection of grasses from North America is probably the richest to be found anywhere. Of these alone there are nearly 15,000 sheets. A great part of these he not only named but labelled and mounted; and it is in the study of the Gramineæ as represented in North America that he has done peculiar service to American botany. It will perhaps be a surprise to many to know that before he took up the grasses as a specialty he had collected and studied mosses extensively. Of late years, however, he devoted all his spare time to the Gramineæ.

The result has been that his writings have been most largely upon grasses and forage plants. His most important paper in an agricultural point of view is probably the special bulletin on the agricultural grasses of the United States, published in 1884. This edition was soon exhausted and in 1889 a new, revised, and enlarged edition was published and has been in great demand. He published several other bulletins treating of grasses from a practical standpoint, those especially important being numbers 1, 3 and 6, of the Botanical Division. He contributed numerous scientific papers on grasses to botanical journals. In 1891, at the earnest solicitation of many correspondents as well as to carry out a long cherished wish of his own, he began the preparation of a monograph of North American grasses. This was prepared amidst the pressure of many official duties and perhaps was somewhat hastily published. The first part was issued February 25, 1892, and the second was being rapidly pushed but was not finished at the time of his death. The work, however, is so advanced that we may hope for its early completion and publication. But larger and more important than this was his Illustrations of North American Grasses. The first volume, issued in two parts, treats of the "Grasses of the

Southwest," and the second volume of the "Grasses of the Pacific Slope." The second part of the latter is still in press. A few months before his death, Dr. Vasey began to describe the new but unpublished grasses which had been accumulating in the herbarium for many years. This work was completed less than a week before he died.

In the year 1888 Dr. Vasey succeeded in bringing to the attention of Congress his long cherished scheme of establishing grass experimental stations in the arid and semi-arid regions of the west. With the assistance of the late Senator Plumb and others, an annual appropriation of $40,000 was obtained for the Botanical Division. This allowed for considerable increase in the scientific force at the herbarium and the sending out of botanical expeditions. The chief object of this appropriation, however, was the establishment of the Grass Experimental Station at Garden City, Kansas. This work has been directly under the charge of Dr. J. A. Sewall. It was Dr. Vasey's idea to experiment here with both native and introduced species for the purpose of obtaining grasses and forage plants adapted to the region west of the 100th meridian where irrigation is not practicable. These experiments have all been made without irrigation and the result of the four years work has justified the outlay in money and has confirmed the wisdom of Dr. Vasey's plan.

Dr. Vasey's name has been twice used in forming generic names; first for a grass named Vaseya by Prof. Thurber. This, however, was properly merged in Muhlenbergia. Recently, Prof. Cogniaux has named a Cucurbitaceous plant Vaseyanthus. Many species also bear his name.

In 1864, Dr. Vasey received the degree of M. A. from the Ill. Wesleyan University. He was a member of the Geographical Society of Washington and a charter member of the Biological Society of the same city. Long a member, in 1889 he was made a fellow of the American Association for the Advancement of Science. He was made an associate fellow of the American Academy of Arts and Sciences on June 15, 1892. He was the joint representative of the Smithsonian Institution and the Agricultural Department to the Botanical Congress at Genoa in 1892, at which he was made one of the Vice-Presidents.

Dr. Vasey was a quiet and dignified gentleman of most kindly feeling and pleasing address. Those connected with him in his work speak with warmth of the pleasant relations

he sustained with them. While conscientiously efficient and firm in his duties, his sweetness of disposition made him beloved by all. To the narrowing circle of the older botanists who have so long known him and cherished his friendship, his loss comes with peculiar force. Few of the American botanists now living have been in touch with a larger circle of friends and correspondents; and some of these have been and always will be pre-eminent in the science.

Dr. Vasey died at Washington on March 4, 1893, after a severe illness of only three days. He leaves a widow and six children.

The following resolutions were passed by the officers of the National Museum at a meeting held on March 6th:

In the death of Dr. George Vasey the National Museum has lost a faithful and efficient officer, and the science of botany an able and indefatigable worker. As botanist of the Department of Agriculture and curator of the National Herbarium for twenty-one years, Dr. Vasey's name has become known to all botanists throughout the world and his contributions to science form an indispensable part of the working library of every botanist. His familiarity with the flora of all parts of the United States, especially with the plants of the great west, was unrivaled and caused his opinion to be sought and respected upon all critical questions relating thereto. He was the recognized authority on this side of the Atlantic in the important department of grasses, and his publications relating to these have great economic as well as scientific value.

Dr. Vasey was uniformly gentle and kind, manifesting a warm interest in the progress of younger botanists and beginners, always ready to give his valuable time and counsels to those who went to him for assistance, and many who are now well known in the science owe their success in large part to the encouragement and stimulation received from him. In this way the circle of his influence was much wider than would be naturally inferred from his quiet life and long confinement to a single post of duty.

To the world at large Dr. Vasey was distinguished for his modest and unobtrusive character, his kindly disposition, and his genial manners. A model husband and father, an estimable neighbor and a good citizen, his loss will be deeply felt by all who knew him. Therefore,

Resolved, That the sympathies of the officers of the National Museum and Smithsonian Institution be extended to the widow and family of the deceased, and that a copy of this minute and resolution be transmitted to them.

Similar resolutions were passed by the scientific corps of the Department of Agriculture.

The following bibliography was prepared by Miss Josephine A. Clark, of the Botanical Division, Department of Agriculture.

1870.

Spring flowers. Amer. Entomol. & Bot. II. 183–184.

The soft maples. Amer. Entomol. & Bot. II. 184–186.

Who should study botany. Amer. Entomol. & Bot. II. 186.

Blood-root. (Sanguinaria Canadensis.) Amer. Entomol. & Bot. II. 187.

Red-bud. (Cercis Canadensis.) Amer. Entomol. & Bot. II. 187–188.

The grasses. Amer. Entomol. & Bot. II. 188–189.
Editorial jottings. (Plants of southern Illinois.) Amer. Entomol. & Bot. II. 191.
The common Virgin's Bower. (Clematis Virginiana L.) Amer. Entomol. & Bot. II. 216.
The herbarium. Amer. Entomol. & Bot. II. 215–216.
Pulsatilla. Amer. Entomol. & Bot. II. 216–217.
How to study the grasses. Amer. Entomol. & Bot. II. 219–220.
The flowering Dogwood. Amer. Entomol. & Bot. II. 221.
Our cultivated grasses. Amer. Entomol. & Bot. II. 222.
The Honey Locust. (Gleditschia triacanthos L.) Amer. Entomol. & Bot. II. 222-223.
The woody Compositæ. Amer. Entomol. & Bot. II. 223.
The oaks. Amer. Entomol. & Bot. II. 249–250.
The rose. Amer. Entomol. & Bot. II. 254.
Origin of prairie vegetation. Amer. Entomol. & Bot. II. 277.
The oaks. Amer. Entomol. & Bot. II. 280–282.
Botanical miscellany—Classification of the oaks. Amer. Entomol. & Bot. II. 282–283.
The American Holly. (Ilex opaca.) Amer. Entomol. & Bot. II. 283–284.
New plants.—Saxifraga Forbesii. Amer. Entomol. & Bot. II. 288.
Foxglove Pentstemon. (Pentstemon digitalis Nutt.) Amer. Entomol. & Bot. II. 310.
Our native oaks. Amer. Entomol. & Bot. II. 311–313, 375–377.
Arborescent grasses. Amer. Entomol. & Bot. II. 377.

1874.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Commis. of Agric. for 1872. pp. 159–179. Washington, 1874.)

1875.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Commis. of Agric. for 1874. pp. 156–160. Washington, 1875.)
Botanical notes [on common plants]. Field & Forest I. 5–6.
Exotic trees in Washington. Field & Forest I. 17–19.
Rare and noteworthy trees in Washington. Field & Forest I. 33–37.

1876.

Forest-trees of the United States. Centennial collection. (In U. S. Dept. of Agric. Rep. of Comm. for 1875. pp. 151–186. Washington, 1876.) Reprinted.
Flora Columbiana; or, Catalogue of plants growing without cultivation in the District of Columbia and its immediate vicinity. pp. 30 + [1]. 8°. Washington, 1876.
Carices in Washington, D. C. Bot. Gaz. I. 37.
Notes on Festuca Thurberi. Bot. Gaz. II. 53.

1877.

Some Oregon Gramineæ. Bot. Gaz. II. 126.

Report of the botanist. (In Dept. of Agric. Report of the Comm. for 1876. pp. 73–74. Washington, 1877.)

Botany at the Centennial. Field and Forest II. 142–144.

1878.

Gramineæ. (In U. S. War Dept. Rep. U. S. geol. surv. G. M. Wheeler in charge, VI. 281–297. Washington, 1878.)

Poa Lemmoni n. sp. Bot. Gaz. III. 13.

Additions to and corrections of the Catalogue of forest-trees of the United States. Bot. Gaz. III. 97–98.

1879.

Panicum littorale n. sp. Bot. Gaz. IV. 106.

Vasey, Geo., and Collier, Peter. Report of the botanist and chemist on grasses and forage plants. (In U. S. Dept. of Agric. Rep. of Comm. for 1878. pp. 157–194. Washington, 1879.)

1880.

Report of the botanist on grasses. (In U. S. Dept. of Agric. Rep. of Comm. for 1879. pp. 349–359. Washington, 1880.)

1881.

Trichostema Parishi Vasey. Bot. Gaz. VI. 173.

Calamagrostis Howellii n. sp. Bot. Gaz. VI. 271.

Alopecurus saccatus n. sp. Bot. Gaz. VI. 290.

Some new grasses—Melica Hallii, Sporobolus Jonesii, Poa purpurascens. Bot. Gaz. VI. 296–298.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of Comm. for 1880. pp. 375–386. Washington, 1881.)

1882.

Some new grasses—Poa pulchella, P. Bolanderi, Stipa Parishii. Bot. Gaz. VII. 32–33.

Notes on N. American grasses, based on Mr. Bentham's recent paper on Gramineæ. Amer. Nat. XVI. 322.

Some new grasses—Muhlenbergia setifolia, M. glomerata var. brevifolia, M. sylvatica var. Californica. Bot. Gaz. VII. 92–93.

The coniferous trees of the United States and Canada. Montreal Herald, Sept. 5, 1882. Reprinted in Amer. Journ. For. I.

Report of the botanist. (In Dept. of Agric. Rep. of the Comm. for 1881–2, pp. 231–255. Washington, 1882.)

1883.

New western grasses. [A list of 29 names.] 1 page. Washington, 1883.

New species of grasses—Agrostis tenuis, A. humilis. Bull. Torr. Club, X. 21.

On three hybrid oaks near Washington, D. C. Bull. Torr. Club, X. 25–26.

Note on Cyperus refractus, Eng. Bull. Torr. Club, x. 32.

Two new species of grasses—Stipa stricta, Aristida Palmeri. Bull. Torr. Club, x. 42–43.

New species of grasses—Sporobolus Wolfii, Danthonia intermedia. Bull. Torr. Club, x. 52.

The grasses of the United States. Bot. Gaz. VIII. 319.

New species of grasses—Agropyrum Scribneri, Sporobolus Buckleyi. Bull. Torr. Club, x. 128–129.

Report of the botanist—Grasses of the Great Plains. (In the U. S. Dept. of Agric. Rep. of the Comm. for 1883. pp. 83–98. Washington, 1883.)

1884.

Agricultural grasses of the United States. pp. 144, 8°. Washington, 1884.

A new grass—Ammophila Curtissii. Bull. Torr. Club, XI. 7.

Schedule of North American species of Paspalum. Bot. Gaz. IX. 54–56.

A new species of grass—Cathestechum erectum. Bull. Torr. Club, XI. 37–38.

A new Aristida—Aristida basiramea. Bot. Gaz. IX. 76–77.

Notes on Eriochloa. Bot. Gaz. IX. 96–97.

New species of grasses—Panicum Chapmani, P. Hallii. Bull. Torr. Club, XI. 61–62.

A hybrid grass. Bot. Gaz. IX. 165–167.

New grasses—Stipa Scribneri, Festuca confinis, Elymus Saundersii. Bull. Torr. Club, XI. 125–126.

Vasey, Geo. and Scribner, F. L. A new Eriochloa—Eriochloa Lemmoni. Bot. Gaz. IX. 185.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Comm. for 1884. pp. 123–136. Washington, 1884.)

1885.

A descriptive catalogue of the grasses of the United States. pp. 110. 8°. Washington, 1885.

New grasses—Trisetum Ludovicianum, Leptochloa Langloisii, L. Nealleyi. Bull. Torr. Club, XII. 6–7.

Some new grasses—Bromus Suksdorfii, B. Orcuttianus, Deyeuxia Cusickii, Deschampsia gracilis. Bot. Gaz. x. 223–224.

Some new grasses—Elymus Orcuttianus, Agropyrum tenerum, A. glaucum R. & S. Bot. Gaz. x. 258–259.

A new grass—Deyeuxia Macouniana. Bot. Gaz. x. 297.

Plants of the Greely Expedition. Bot. Gaz. x. 364–366.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Comm. for 1885. pp. 63–88. Washington, 1885.)

1886.

Report of an investigation of the grasses of the arid districts of Kansas, Nebraska, and Colorado. pp. 18. 8°. Washington, 1886. (U. S. Dept. of Agric. —Bot. Div. Bull. 1.)

New American grasses—Eriochloa mollis var. longifolia, Panicum Nealleyi,

P. repens var. confertum, P. virgatum var. macranthum, var. confertum, var. elongatum, var. diffusum, Imperata brevifolia, Aristida Arizonica, A. Havardii, A. Orcuttiana, A. Schiediana var. minor. Bull. Torr. Club, XIII. 25–28.

Tuberiferous Hydrocotyle Americana. Bull. Torr. Club, XIII. 28–29.

New American grasses—Aristida Reverchonii, Stipa Lettermani, Muhlenbergia Parishii, M. Californica, M. Wrightii, Agrostis depressa, A. exarata var. stolonifera, var. littoralis, A. foliosa, A. Diegoensis, A. Oregonensis, Deyeuxia Cusickii. Bull. Torr. Club, XIII. 52–56.

Notes on Eatonia. Bot. Gaz. XI. 116–117.

Gramineæ. (In Watson, S. List of plants collected by Dr. Edw. Palmer in southwestern Chihuahua, Mexico, in 1885. Proc. Amer. Acad. XXI. 442–444.)

National herbarium at Washington. Bot. Gaz. XI. 153–156.

New grasses—Trisetum montanum, Diplachne Reverchoni, Glyceria Lemmoni, Festuca Texana, Elymus Macounii, E. nitidus. Bull. Torr. Club, XIII. 118–120.

Synopsis of the genus Paspalum. Bull. Torr. Club, XIII. 162–168.

A new genus of grasses—Orcuttia. Bull.Torr. Club, XIII. 219; West Amer. Sci. III. 4–6.

New grasses—Sporobolus Bolanderi, Agrostis attenuata, A. foliosa, Muhlenbergia Neo-Mexicana, M. acuminata. Bot. Gaz. XI. 337–338.

New species of Mexican grasses collected by Dr. Edw. Palmer, in southwest Chihuahua, in 1885. Bull. Torr. Club, XIII. 229–232.

1887.

Desiderata of the herbarium for North America, north of Mexico; Ranunculaceæ to Rosaceæ, inclusive. pp. 15. 8°. Washington, 1887. (U. S. Dept. of Agric.—Bot. Div. Bull. 4.)

Grasses of the South; a report on certain grasses and forage plants for cultivation in the south and southwest. pp. 63. 8°. Washington, 1887. (U. S. Dept. of Agric.—Bot. Div. Bull. 3.)

New species of Mexican grasses—Sporobolus Shepherdi, S. annuus, S. racemosus. Bull. Torr. Club, XIV. 8–10.

[Review of] Grasses of North America, for farmers and students.—W. J. Beal. Vol. I. 1887. Bull. Torr. Club, XIV. 103–104.

New grasses—Poa rupestris, Panicum Havardii. Bull. Torr. Club, XIV. 94–95.

Special uses and properties of some Mexican grasses. Bull. Torr. Club XIV. 98–100.

Gramineæ. (In Watson, S. List of plants collected by Dr. Edw. Palmer, in the state of Jalisco, Mexico, in 1886. Proc. Amer. Acad. XXII. 459–462.)

Redfieldia, a new genus of grasses. Bull. Torr. Club, XIV. 133–134.

Fasciation in Sophora secundiflora. Bot. Gaz. XII. 160–161.

The new California Poa—Poa Orcuttiana. West Amer. Sci. III. 165–166.

Botany at the Department of Agriculture. Bull. Torr. Club, XIV. 203–205.

[Review of] Grasses and forage plants. By Charles L. Flint. Bot. Gaz. XII. 301–302.

Notes on the Paspali of Le Conte's monograph. Proc. Acad. Phila., 1886. 284–285.

Report of the botanist. (In U S. Dept. of Agric. Rep. of the Comm. 1886. pp. 69–93. Washington, 1887.)

1888.

New western grasses—Poa macrantha, P. argentea Howell, Alopecurus Howellii, A. Macounii, A. geniculatus var. robustus, A. Californicus. Bull. Torr. Club, xv. 11–13.

New or rare grasses—Triodia Nealleyi, T. repens, Bouteloua stricta, Stipa flexuosa, Sporobolus Nealleyi, Poa Tracyi, Diplachne Tracyi. Bull. Torr. Club, xv. 48–49.

Synopsis of the genus Panicum Linn. Bot. Gaz. XIII. 96–97.

Notes on Hackel's monograph of Gramineæ. Bull. Torr. Club, xv. 116–117.

Rules for the Botanical exchange club. Bot. Gaz. XIII. 160–161; Bull. Torr. Club, xv. 167–168.

The Exchange club. Bot. Gaz. XIII. 161–162.

Characteristic vegetation of the North American desert. Bot. Gaz. XIII. 258–265.

On two species of Gramineæ—Sporobolus confusus, Melica Smithii. Bull. Torr. Club. xv. 293–294.

Notes on some rare grasses—Andropogon Hallii, Redfieldia flexuosa. Bull. Torr. Club. xv. 294–295.

Description of Alopecurus Stejnegeri, a new species of grass from the Commander Islands. Proc. U. S. Nat. Mus. 1887. x. 153.

Grasses of the arid districts. pp. 61. 8°. Washington, 1888. (U. S. Dept. of Agric.—Bot. Div. Bull. 6.)

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Comm. for 1887. pp. 301-21. Washington, 1888.)

1889.

Gramineæ. (In Watson, S. Collection of plants made by Dr. Edw. Palmer, in 1887, about Guaymas, Mexico, at Muleje and Los Angeles Bay in Lower California, and on the Island of San Pedro Martin in the Gulf of California. Proc. Amer. Acad. XXIV. 79–81.)

The National Herbarium. Bot. Gaz. XIV. 158–159.

List of plants from Lower California sent to the Smithsonian Institution by Lieut. C. F. Pond, U. S. N. Proc. U. S. Nat. Mus. 1888. XI. 368.

New or little known plants —Uniola Palmeri. Gard. and For. II. 401.

Agricultural grasses and forage plants of the United States. Ed. 2, rev. & enl. pp. 148. 8°. Washington, 1889. (U. S. Dept. of Agric.—Bot. Div. Special Bulletin.)

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Comm. for 1888. pp. 305–324. Washington, 1889.)

Vasey, Geo., and Galloway, B. T. A record of some of the work of the [Botanical] Division including extracts from correspondence and other communications. pp. 67. 8°. Washington, 1889. (U. S. Dept. of Agric.—Bot. Div. Bull. 8.)

Vasey, Geo., and Rose, J. N. List of plants collected by Dr. Edw. Palmer, in Lower California, in 1889. Proc. U. S. Nat. Mus. 1888. XI. 527–536.

1890.

List of the plants collected in Alaska in 1888. Proc. Nat. Mus. 1889. XII. 217–218.

Cactus landscapes. Amer. Gard. XI. 468–470.

A new grass—Rhachidospermum Mexicanum. Bot. Gaz. XV. 106–110.

Gramineæ. (In Coulter, J. M. Collection of plants made by G. C. Nealley in the region of the Rio Grande, in Texas, from Brazos Santiago, to El Paso county. Contr. Nat. Herb. I, no. 2. 52-61.)

Vasey, Geo., and Rose, J. N. (1) Plants collected by Dr. Edw. Palmer, in 1888, in southern California. (2) Plants collected by Dr. Edw. Palmer, in 1889, at Lagoon Head, Cedros Island, San Benito Island, Guadalupe Island, and Head of the Gulf of California. Contr. Nat. Herb. I. 1–28.

Notes on Melica and Poa. Bull. Torr. Club, XVII. 178–179.

Illustrations of North American grasses. Grasses of the Southwest. I. pt. I. roy. 8°. pp. [50]. pl. 50. Washington, 1890. (U. S. Dept. of Agric.—Bot. Div. Bull. 12.)

The translation of Hackel's True grasses. Bot. Gaz. XV. 268–269.

Vasey, Geo., and Rose, J. N. List of plants collected by Dr. Edward Palmer, in 1890, in Lower California and western Mexico. Contr. Nat. Herb. I. 63–90.

Report of the botanist. (In U. S. Dept. of Agric. Rep. of the Comm. for 1889. pp. 379-396. Washington, 1891.)

1891.

New grasses—Sporobolus pilosus, Bouteloua uniflora, Andropogon macrourus var. pumilus. Bot. Gaz. XVI. 26–27.

New grasses—Orcuttia Greenei, Eragrostis spicata, Muhlenbergia Alamosæ, Calamagrostis densus, C. kœlerioides. Bot. Gaz. XVI. 145–147.

Gramineæ. (In Rose, J. N. Plants collected by Dr. Edw. Palmer, in 1890, in western Mexico and Arizona. Contr. Nat. Herb. I. 114–115.)

A new grass—Melica (?) multinervosa. Bot. Gaz. XVI. 235–236.

A neglected Spartina—Spartina junciformis Engelm. & Gray. Bot. Gaz. XVI. 292.

Grasses of the Southwest. vol. I. pt. 2. pp. (50) pl. 50. roy. 8°. Washington, 1891. (U. S. Dept. of Agric. Bot. Div. Bull. 12.)

Vasey, Geo. and Rose, J. N. Plants collected, in 1889, at Socorro and Clarion Islands, Pacific Ocean. Proc. U. S. Nat. Mus. 1890. XIII. 145–149.

Report of the botanist. (In Dept. of Agric. Rep. of the Sec'y for 1890. pp. 375–392. Washington, 1891.)

Report on the Dept. of botany in the U. S. National Museum 1889. (In Smithson. Inst.—U. S. Nat. Mus. Rep. 1889. p. 399. Washington, 1891.)

Report on the Dept. of botany in the U. S. National Museum 1890. (In Smithson. Inst —U. S. Nat. Mus. Rep. 1890. pp. 237–239. Washington, 1891.)

1892.

Monograph of the grasses of the United States and British America. pt. I. Contr. Nat. Herb. III. 1-89.

Grasses of the Pacific slope, including Alaska and the adjacent islands. pt. 1.[1] roy, 8°. pp. (50) pl. 50. Washington, 1892. (U. S. Dept. of Agric.--Bot. Div., Bull. 13.)

Report of the botanist[2]. (In U. S. Dept. of Agric. Rep. of the Sec'y for 1891. pp. 341-358. Washington, 1892.)

Wilmington, Del. and Washington, D. C.

Frost freaks of the dittany.

BY LESTER F. WARD.

WITH PLATE XIX.

One bright, crisp, frosty morning (Dec. 5, 1892), as I was taking a delightful ramble with my congenial friend Mr. Victor Mason and following the pleasant road that leads from the little Virginia village of Accotink toward the tomb of Washington, some white objects looking like icicles close to the ground on our right along the border of a pine wood arrested our attention. After remarking a number without stopping to inspect them they presently grew so numerous and exhibited such a uniformity that the scientific instinct could no longer be restrained and we turned aside to satisfy our curiosity.

We found that they were in truth nothing but ice, but that instead of icicles they were veritable freaks of frost. Every one was firmly attached to the stem of a small herbaceous plant which had succumbed to the season but still stood erect. The attachment was always close to the base, often at the very ground, sometimes an inch above. At a distance the frost-works had the appearance of cylindrical masses, but one need not come very near to see that such was not the case. In fact they really consisted of several thin foils or wings from one to three inches in width, firmly attached by one edge to the stem of the plant, thus standing in a vertical position. From this attachment each of these little ice sheets projected out horizontally or with a slight upward tendency, not straight and stiff, but gently and gracefully curving or coiling into a beautiful conch-like roll at the distal margin. There were always several of these, usually three, four, or five, all attached

[1]Part 2 of this work will be issued June 1, 1893.—J. N. R.
[2]Report of the botanist for 1893 will be issued in June, 1893.—J. N. R.

to the same vertical portion of the stem but at regular intervals around it like the paddles of a flutter-wheel, but all curving in the same direction after the manner of a turbine wheel. Thus, where there were four they stood with each pair opposite, as in the accompanying cuts, of which fig. 1 represents a cross-section and fig. 2 a side view. The amount of curving varied considerably, and the coil sometimes filled up most of the interval between the plates giving the object a compact appearance. The ice was white, opaque, and singularly light, as if consisting of congealed froth, but in all cases the scrolls bore horizontal stripes like those of a flag, resulting from degrees in the whiteness, varying from alabaster to nearly transparent. These stripes added greatly to the beauty of these singular objects. In some cases the inner margin, instead of being straight was sinuous (fig. 3), giving a fluted character to the base of the wing (fig. 4). Many other peculiarities were noted in these evanescent toys, as holding them in our hands we walked along discussing and admiring them; but as they soon vanished and memory is treacherous, I refrain from further details.

But what propriety is there in publishing this purely physical phenomenon in a botanical journal? Just here is the chief wonder. There grew in the same situation some dozen or twenty small herbaceous plants of about the same general character which would all seem equally liable to exhibit such a phenomenon. There were species of Aster, Solidago, Chrysopsis, Pycnanthemum, Polygonum, Ludwigia, Sericocarpus, etc., etc., and with these in considerable but not specially marked abundance, *Cunila Mariana*. The first frost-works seen were attached to this plant, which we supposed for a while to be an accident; but soon we perceived that such was not the case, and an examination of hundreds of cases revealed the fact that they were exclusively confined to this species. No sign or semblance of them could be found on any other plant. They were, therefore, so far as our observation went, a specific character, and it is this alone which has prompted me to give the above account in the hope that others might be able to confirm or invalidate this induction by a wider one.

This plant, at least in this latitude, persists after frost with all its branches, sear leaves, and empty seed-vessels intact, so that its identity is as complete as it was in midsummer. The bark, which remained firm everywhere else was seen to be

longitudinally split into strips at the zone occupied by the frost-work, but as it could be seen between the several ice sheets, these rifts must have been covered by their bases. In other words, it cannot be doubted that the liquid matter out of which they were formed had passed through these longitudinal openings and been deposited by molecular accretions in the symmetrical forms observed. We inferred from this that they might consist entirely of the juices of the plant, and made the only chemical test in our power, namely, that of placing them on the tongue. The result was wholly negative, as nothing distinguishable from pure distilled water could be detected. As the upper part of the stems was dead and dry and the roots perennial, the conclusion was that the water had by some agency been pressed or drawn up through the cambium layer of the roots from the soil and forced out through these apertures in the bark. The action of frost in the ground might account for the required pressure, and the whole would be thus explainable on physical principles. But it explains too much, since no reason can be assigned why the phenomenon should not be universal and not confined to a single species.

Since making these observations I have been to some pains to ascertain whether any one else has witnessed this phenomenon and thus far have found no record. It is possible that this is the first time that *Cunila Mariana* has been discovered to be a frost-weed. At the time the discovery was made it had quite escaped my memory that *Helianthemum Canadense* behaves in a similar way. That plant is not common in this region and I have not yet had an opportunity to observe it at the proper season. The statement in the first edition of Gray's Manual, 1848, where the name "frost-weed" is given to this species, that "late in autumn crystals of ice shoot from the cracked bark at the root, whence the popular name," repeated in all subsequent editions and copied into many other books, is doubtless founded on earlier recorded observations, but is not found in Nuttall or Pursh. My attention was called to it by Prof. J. C. Arthur, who also referred me to a figure in Mr. Wm. Hamilton Gibson's recent book entitled "Sharp Eyes."[1] This figure is somewhat fanciful, being a vignette constituting the first letter of this chapter of his book and aiming to show all the parts of the

[1]New York, 1892. Article "The Frost Flower," pp. 210–211.

plant in addition to the frost work. Although it is, according to this representation, a much less definite and less beautiful object than our dittany "frost flowers," there can be no doubt that the principle on which it was formed is the same. The author's description of it as "fashioned into all sorts of whimsical feathery curls and flanges and ridges" indicates at once the inadequacy of his figure to do it justice and the close analogy between it and the "frost flower" of Cunila.

We shall probably soon hear of other plants that have a similar habit.

U. S. National Museum.

EXPLANATION OF PLATE XIX.

Fig. 1. Cross-section of a four-winged frost-work, generalized. Fig. 2. Side view of same, showing mode and position of attachment to stem. Fig. 3. Illustration of sinuous margin of some of the foils. Fig 4. Side view of same, showing fluted or gathered appearance.

BRIEFER ARTICLES.

On two new or imperfectly known Myxomycetes.—WITH PLATE XX.—**Comatricha caespitosa** n. sp. Pl. xx, figs. 1–4.—Sporangia *densely crowded or cespitose*, rising from a delicate hypothallus. Individual sporangia *very shortly stipitate or subsessile, clavate*, 1–1.5^{mm} high. Sporangial wall grey, iridescent with blue tints, comparatively permanent but finally disappearing. Columella rising to two-thirds or three-fourths of the height of the sporangium, and giving rise throughout its length to the dense, blackish capillitium. Main branches of the capillitium thick at the point of origin, frequently anastomosing and becoming gradually thinner toward the surface of the sporangium; tips pointed, *free, not attached to the wall of the sporangium, and forming no peripheral network.* Spores globose, *distinctly asperate*, 9.6–12.8μ in diameter, pale brownish-violet by transmitted light, blackish-violet in the mass.

On moss, and lichens of the genus Cladonia, Wood's Holl, Mass., August, 1892, *W. A. Setchell.*

This interesting species is characterized by its densely cespitose habit, more or less permanent sporangial wall, and large, asperate spores. The individual columellas sometimes exhibit marked variations from the type, variations which might be taken to indicate abnormal developments. On the whole, however, the principal characteristics of this Comatricha seem to be of definite specific value, if we

regard only those characteristics which are common to normal and fully-developed specimens.

PHYSARUM SULPHUREUM Alb. and Schw. Consp. Fung. p. 93. tab. 6. fig. 1.—Plate XX, figs. 5–8.

SYNONYMS.—*Physarum virescens* Fckl. non Ditm. *Physarum chrysotrichum* B. & C. *Physarum decipiens* Curt. *Badhamia decipiens* (Curt.) Berk. *Physarum inæqualis* Peck.

Sporangia scattered, stipitate or occasionally sub-sessile, spherical, 0.8–1^{mm} high. Wall granulated, bright golden-yellow. Stem, when present, one-half to two-thirds the height of the sporangium, blackish-brown. Hypothallus minute, thin, brown. *Columella absent.* Capillitium rather dense, composed of *large, angular nodes, completely filled with bright yellow granules of lime,* and connected by very short, delicate, colorless internodes destitute of lime. Spores globose, minutely verruculose or asperate, 10.7–11.8μ in diameter, brownish-violet by transmitted light, black in the mass.

On bark of apple-trees, Manchester, Mass., August, 1889, *W. C. Sturgis.*

Our knowledge of this species is based upon the rather meager description and figures by Albertini and Schweinitz above referred to, and a scanty specimen preserved in the Schweinitz herbarium. There can be little doubt that the species described above is identical with that collected by Schweinitz as *Physarum sulphureum* A. and S., and it is fair to presume that Schweinitz had sufficient grounds for considering his American specimen to be identical with that found in Europe.

This species is interesting as exhibiting the close relationship existing between the two genera Physarum and Badhamia. Were it not for the few short, empty tubules which serve to connect the large nodes of the capillitium, the species would certainly be referable to Badhamia. The nature and brilliant color of the capillitium, and the absence of a columella, serve to separate it from the other yellow species of the genus Physarum.—W. C. STURGIS, *New Haven, Conn.*

EXPLANATION OF PLATE XX.—Figs. 1–4. *Comatricha caespitosa* n. sp.—Fig. 1. Habit. × 10. Fig. 2. Single sporangium with capillitium and part of wall. × 40. Fig. 3. Portion of capillitium and columella. × 240. Fig. 4. Spores. × 500.

Figs. 5–8. *Physarum sulphureum* A. and S.—Fig. 5. Habit, natural size. Fig. 6. Sporangia showing capillitium. × 50. Fig. 7. Portion of capillitium and spores. × 240. Fig. 8. Spores. × 500.

On the vegetation of hot springs.—Accidentally, in looking over some notes that I made in 1889, I found a number of references to vegetation at a very high temperature. These caused, I remember, a good deal of sensation among my friends as well as in my own mind, and I should, indeed, not venture to place them in any journal, if not

such names as Alex. von Humboldt and Sir J. D. Hooker stood behind the facts reported. Having here no means of verification of the question I choose to reproduce my notes, not only because they are very interesting, but especially in order to find out if any one is able to give an explanation of the matter. Probably my article will be seen by some botanist who has an opportunity to investigate the subject.

1. A. von Humboldt makes the following remark,[1] giving an account of his and Bonpland's expedition to the hot springs at Trinchera. "Die Ueppigkeit der Vegetation um das Becken überraschte uns. Mimosen mit zartem, gefiedertem Laub, Clusien und Feigenbäume haben ihre Wurzeln in den Boden eines Wasserstücks getrieben, dessen Temperatur 85° betrug. Ihre Aeste stehen nur zwei, drei Zoll über dem Wasserspiegel. Obgleich das Laub der Mimosen beständig vom heissen Wasserdampf befeuchtet wird, ist es doch sehr schön grün. Ein Arum mit holzigtem Stengel und pfeilförmigen Blättern wuchs sogar mitten in einer Lache von 70° Temperatur. Dieselben Pflanzenarten kommen anderswo in diesem Gebirge an Bächen vor, in denen de Thermometer nicht auf 18° steigt."—This statement indicates a very singular adaptation in the plants mentioned. The centigrade scale was used. In his immortal *Rélation historique* (II. 98) Humboldt tells the facts in the same way, and *Kosmos* (IV, 1874, 487–88) also states them.

2. Sir J. D. Hooker says[2] that a hot spring which he visited in India has a maximum temperature of 190° F. (about 90° C.), and yet he found a *Cyperus*, and an *Eleocharis*(?) there, "having their roots in water of 100°, and where they are probably exposed to a greater heat."

3. Sonnerat[3] found in a spring on Luzon *Aspalatus* and *Vitex agnus castus*, having their roots in water of 85° C.

4. Stanton found[4] on the island of Amsterdam a spring, in the bottom of which *Marchantia* and *Lycopodium* were fixed, the temperature being 186° F. (86° C.).

5. Sekondat found *Tremella* in water of 62° C., while Dunbar and Hunter in springs in Louisiana noted *Conferva* as well as higher plants growing in or being influenced by water of 50°–62° C.[5]

6. Schouw saw a moss in air of 50° C. on Ætna, Sicily.

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[1] Reisen in d. Equinoctialgegenden, ed. 1874, II. 198.

[2] Hooker's Journal of Botany I (1849). 50; Himalayan Journals II. 138.

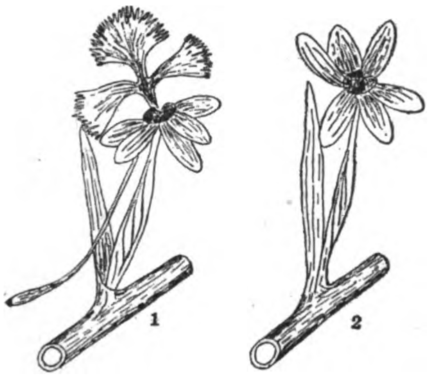
[3] Journal de Physique, 1774, p. 256; Voyage à la nouvelle Guinée, 1776, pp. 38–42.

[4] See Voit, Magazin für den neuesten Zustand der Naturkunde, I (1798), 22.

[5] See H. G. Bronn: Handbuch einer Geschichte der Natur, II (1843). 44–45 for references.

7. Goeppert found[6] the mosses, *Dicranum purpureum*, *Bryum caespiticium*, *Bryum argenteum*, *Funaria hygrometrica*, and further, *Poa annua*, *Agrostis vulgaris*, *Hypochaeris radicata*, and *Polygonum aviculare* in a place where they were in contact with steam or vapor of 63° C.; while he found, three inches under the surface, a temperature of 56° C.

On the well-known phenomenon of certain algae being found in hot springs, I could bring a good deal together here, but it is known that Cohn many years ago took this question up. For the other facts, I am able to give no explanation, when I consider the much written on temperature-maxima for growth and other life phenomena.—J. CHRISTIAN BAY, *Missouri Botanic Garden.*



HABENARIA FIMBRIATA.
1, normal form; 2, variety.

Habenaria fimbriata, var. —During a collecting tour with Mr. H. E. Sargent, in the summer of 1892, a large quantity of the type form of this orchid was found August 2nd, in full bloom, in moist woods a few miles east of Lynn, N. H. This species is much less common than the nearly related species, *H. psychodes.* The latter at the above date had barely begun to bloom, while *H. fimbriata* had in some cases passed its prime already. In color, an unusual number of spikes were nearly white and a large number were gathered in a hasty run through the woods. In addition two spikes of a very peculiar variety were found, but were not noticed at the time, or others would have been looked for. One of the two had the light purple flowers of the type while the other was white. In size and foliage there was nothing unusual about them, except that the spikes were much more slender than the type and linear rather than oblong. The flowers, however, were strangely modified, as is shown in the figures accompanying this paragraph. Fig. 1 is the ordinary form, fig. 2, the variety. In the variety the sepals and petals are all entire and alike in form and size, except as in two or three flowers on one of the spikes there is a slight suggestion of a fringed lip. The long and prominent spur, in the type moreover, is here entirely wanting, the ovary is considerably longer and more

[6] Wiegmann's Archiv für Naturgeschichte, 1 (1837). 208-210.

slender, and the bracts are most of them linear lanceolate instead of lanceolate. It would be of interest to the writer to learn whether the above variety has often been met with, and whether similar variations occur in other species or genera of this order.

Since the above was written the February number of the *Torrey Bulletin* has come to hand. Reference is there made (p. 37,) to *Habenaria blephariglottis*, var. *holopetala* Torr., as having entire petals at times, and (p. 38), to a variety of *H. ciliaris*, collected during the past season in the vicinity of New York, in which the lip was either imperfectly fringed or entire, while the spur was either very short or obsolete. The figures given above, therefore, only illustrate the extremes of variation found within the limits of the genus.—HENRY G. JESUP, *Hanover, N. H.*

EDITORIAL.

THE need of a comprehensive index to the writings of American botanists becomes more urgent every year. What Farlow's index did for writings upon fungi, should be done for every other department of the science, and provision ought also to be made for keeping the index up to date. The index to current literature in the *Bulletin of the Torrey Club*, is valuable, and a specially interesting feature of the journal, but is necessarily restricted and imperfect. It was a most excellent idea to provide an index and abstracts of the publications sent out by the experiment stations in the form of a serial, the *Experiment Station Record*, but the multiplicity of subjects included makes it rather unhandy for the use of the specialist.

There are other bibliographical aids to historical research that are of some service, but all told, the facilities for ascertaining what has been written in America upon a particular subject are meager and annoyingly imperfect.

The need of such an index was formerly not strongly felt except by a few workers, but recently it has become the fashion (may it never depart) to include in every considerable research a more or less complete historical review, and in all matters of moment to give the connection of the observations with previously recorded facts. With the present lack of any suitable index this is often a formidable task, and is usually attended with great uncertainty, particularly in regard to American records.

Could such an admirable work as Just's *Jahresbericht* be provided for the current writings of American botanists, it would not only be

serviceable upon this side of the ocean, but would be especially welcome to investigators in other countries. Commercial publishers are willing to undertake the financial management of such serials abroad, but here probably the only way to succeed would be to have the responsibility assumed by a university having a reputation and endowment that would guarantee permanency. It is very doubtful if the income from subscriptions would meet the expense of publication.

If such a serial were established, there would still remain the necessity for an index of earlier publications. Among the various ways in which this might be accomplished, probably one of the most effective would be by co-operation through the section of botany in the American Association. It could by this means be managed so as not to be a formidable undertaking. The expense of the printing might possibly be arranged for with the Association, or the Smithsonian Institution.

The sooner the work is done the shorter the task, and the more rapid and satisfactory will be the growth of botanical science upon American soil. That it must eventually be done does not admit of doubt.

CURRENT LITERATURE.

Classification of monocotyledons.

A recent monograph by Dr. A. Engler[1] will be found especially helpful to those interested in the classification of angiosperms. It will be seen that the author's arrangement of the monocotyledons differs considerably from that of Eichler, which, with slight modification, is repeated by Goebel, and also from that of Drude. Engler divides the monocotyledons into two great divisions: (1) Those with prevailing inconstancy in the number of parts of the flower, and (2) those with complete or reduced pentacyclic flowers.

The first division includes those families in which the typical nakedness of the flower, spiral arrangement, and inconstancy in the number of parts of the flower may be observed. The arrangement is easily understood, and seems to be sustained by the facts. The different series and their families are as follows:

A. Families with a prevailing inconstancy in the number of floral parts.

I. *Pandanales.*—(Pandanaceæ, Typhaceæ, Sparganiaceæ.)

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[1] ENGLER, A.—Die systematische Anordnung der Monokotyledoneen Angiospermen. Akademie der wissenschaften. pp. 1–55. Berlin, 1892.

II. *Helobiæ.*—The common characteristic of this series (Triuridaceæ excepted) is that the small endosperm is destroyed by the embryo before germination. (Juncaginiaceæ, Butomaceæ, Hydrocharidaceæ, Potomogetonaceæ, Naiadaceæ, Aponogetonaceæ, Triuridaceæ.)

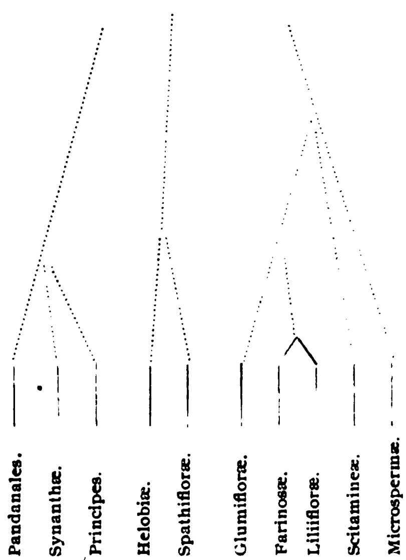
III. *Glumifloreæ.*—(Cyperaceæ, Gramineæ.)

IV. *Principes.*—(Palmæ.)

V. *Synanthæ.*—(Cyclanthaceæ.)

VI. *Spathifloræ.*—(Araceæ, Lemnaceæ.)

B. Families with complete or reduced pentacyclic flowers.



VII. *Farinosæ.*—The important characteristic of this group (aside from exceptions which are explained) is the distinct mealy endosperm whose cells have thin walls and are filled with connected starch grains. (Flagellariaceæ, Restionaceæ, Centrolepidaceæ, Mayaceæ, Xyridaceæ, Eriocaulaceæ, Raptaceæ, Bromeliaceæ, Commelinaceæ, Pontederiaceæ, Philydraceæ.)

VIII. *Liliifloreæ.* — Endosperm mostly of thick-walled cells, containing only protoplasm and oil. (Juncaceæ, Stemonaceæ, Liliaceæ. Hemodoraceæ, Velloziaceæ, Taccaceæ, Dioscoreaceæ, Iridaceæ.)

IX. *Scitamineæ.*—(Musæ, Zingiberaceæ, Canneæ, Maranteæ.)

X. *Microspermæ.*—(Orchidaceæ, Apbstasieæ, Burmaniaceæ.)

The accompanying diagram will serve to give a general view of the series of monocotyledons according to their mutual relationships.

D. M. Mottier.

Minor Notices.

The North American species of Lespedeza form the subject of the 34th contribution from the Herbarium of Columbia College, which appears in *Trans. N. Y. Acad.* xii, under the authorship of N. L. Britton. Twelve species are recognized, full descriptions and synonymy given, and two new varieties proposed. The delimitation of these species has always been a troublesome thing, and as Dr. Britton has had the opportunity of examining most of the type specimens it is to be hoped that the "straightening out" has been effectual.

THE SECOND and enlarged edition has reached us of a compact and handy little flora of the East Frisian islands,[1] which lie like a barrier off the coast of Holland and East Friesland. After a brief account of the flora, suitable keys to the families of angiosperms are followed by concise description of the species. We should be glad to see some such floras of parts of this country.

NOTES AND NEWS.

AN INTERESTING account of the Ray herbarium is given by Mr. James Britton in the *Journal of Botany* for April.

REV. ARTHUR C. WAGHORNE, of Newfoundland, is offering sets of Newfoundland and Labrador plants for sale. The plants are authoritatively named and include cryptogamic material. His address is at New Harbor.

BULLETINS 31–40, of the Botanical Department of Jamaica, in addition to much useful information concerning matters that directly pertain to the Public Gardens and Plantations, contain a continuation of the synoptical list of the Ferns of Jamaica, by Superintendent Jenman, including descriptions of new species.

DR. KARL PRANTL'S work in the preparation of the great "Natürlichen Pflanzenfamilien" will be continued by Dr. Engler alone. Parts 80 and 81 of this work, just issued, contain Rhizophoraceæ by Schimper, Myrtaceæ by Niedenzu, Sterculiaceæ by Schumann, Dilleniaceæ and Ochnaceæ by Gilg, and Eucryphiaceæ by Focke.

THE GAZETTE would be glad to give the names and addresses of all botanists who are to be at the World's Fair in charge of exhibits, so that visiting botanists may readily find them. The form of announcement will be as follows:
DR. CHARLES F. MILLSPAUGH: in charge of West Virginia Forestry Exhibit: intersection main aisles, Forestry Building.

THE SECOND publication of the Botanical Survey of Nebraska, which is being conducted by the Botanical Seminar of the State University, makes a report on collections made in 1892. It includes notes and lists of plants from the Sand Hill region of Sheridan and Cherry counties, notes on the cañon flora of Sioux county, and miscellaneous additions to the state flora, together with new or noteworthy species.

A BIOGRAPHICAL sketch of the late Dr. J. S. Newberry, prepared by Dr. N. L. Britton, appears in the *Bulletin of the Torrey Botanical Club* for March, including a fine portrait and full bibliography of his botanical writings. A plate of Torrey's genus Newberrya is also given. The sketch is written by one of Dr. Newberry's associates, who had abund-

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[1] BUCHENAU, FRANZ:—Flora der Ostfriesischen Inseln. 12mo. pp. viii, 176. Norden u. Norderney; H. Braams. 1891.

ant opportunity to know his worth. Although more strictly a geologist, Dr. Newberry's contributions to botany are surprisingly numerous, especially in the field of paleobotany. His connection with some of the early and important exploring expeditions enabled him to do much service to botany in the way of plant collections, no less than ten living species being named in his honor, in addition to the genus referred to. Of the 197 titles included in his bibliography, 39 are credited to botany.

DR. OTTO KUNTZE, having returned from his South American trip, asks that the international committee on botanical nomenclature give him opportunity to demonstrate what he calls "the absurdities of the Genoa Congress." There can be no doubt but that any botanist who has anything to say concerning nomenclature will be gladly heard. The committee is simply a representative body, and is merely intended to formulate the opinion of the majority of working botanists.

THE WELL-KNOWN naturalist and explorer of Brazil, Central America and Mexico, August B. Ghiesbreght, died on the 7th of February, in the eighty-second year of his age. In numerous and prolonged travels throughout all parts of tropical America Ghiesbreght has brought to light great numbers of new and interesting plants, and his collections enrich all of the principal herbaria and gardens of the world. A glance at the monumental "Biologia Centrali-Americana" is sufficient to show the vast extent of his labors, which are commemorated by the specific names of many plants and animals and especially in the arboreous fig-wort, *Ghiesbreghtia grandiflora*, which Dr. Gray dedicated to him.

MR. HENRY E. SEATON, Assistant Curator of the Gray Herbarium at Harvard University, died suddenly April 30th. He was a young botanist of unusual promise. In the summer of 1891 he made a botanical exploration of Mt. Orizaba, and had just completed a study of his material for distribution. In connection with Dr. Coulter he had determined the Compositae of Mr. John Donnell Smith's Guatemalan collection, and during this past winter, in connection with Dr. Robinson, determined the last Pringle collection, which has just been distributed. Trained thoroughly in modern methods he was bringing to the study of systematic botany the knowledge of general morphology which it so much demands, and systematists can ill afford to lose such carefully prepared young men.

THE DEATH of Alphonse De Candolle, April 4th, at his home in Geneva, in his eighty-seventh year, removes not only one of the oldest but one of the greatest of the botanists of our time. His long life of incessant activity, continuing the labors and reputation of his father, Auguste Pyramus De Candolle, has left the science of botany greatly his debtor. His name must always be familiar to students of systematic botany, both on account of the numerous monographs that he either prepared or directed, and because of the important *Lois de la Nomenclature Botanique* which he formulated in 1867 for the Paris Congress, and which is now referred to as the "Paris Code." The extent of his labors is marvelous, and when one comes to put together his bibliography it seems impossible that one man could have accomplished so much. That monumental work, the *Prodromus*, was be-

gun by his father in 1824, under whose direction seven volumes were published. The remaining ten volumes bear the name of Alphonse De Candolle, and when the dicotyledons had been completed, and the work as originally planned discontinued, under the same untiring direction seven volumes entitled *Monographiæ Phanerogamarum* appeared as a continuation in fact if not in form. Of the usefulness of this greatest production of the De Candolles it is not necessary for any systematist to speak. It is not merely useful, it is indispensible. De Candolle's name will also always be associated with geographical botany, for his *Geographic Botanique* (1855) is one of the classics of that subject. In 1880 he published his *La Phytographie*, an exceedingly useful book, packed full of life-long experience and information. It would be useless to attempt to even mention all his work. He was more than a self-centered writer, for even in his advancing years his enormous correspondence kept him in constant and kindly touch with the younger generation of botanists, and his frank and helpful letters were written without stint. The name of De Candolle is worthily perpetuated in the son Casimir, and the family record of three generations of distinguished botanists is a wonderful one.

DR. DANIEL C. EATON, of Yale University, and Mr. Edwin Faxon, of Jamaica Plain, propose to issue in about two years sets of specimens of North American Sphagna. The number of species attributed to the United States and British America is now nearly fifty, and many of them have never been distributed. For anything like a full series, there should be about one hundred and thirty forms in the collection. Not less than sixty sets of the specimens will be prepared and a set will be given to each person who may supply three or more acceptable forms in quantity sufficient for distribution. The remaining sets will be used for foreign exchanges, and for sale. Promises of assistance have been received already from collectors, and others, and there is every reason to hope that the collection may be made to include nearly all the known species of temperate North America. Any species that are in the least degree doubtful will be submitted to Dr. C. Warnstorf, for final determination. The coöperation of American botanists is respectfully asked for. Letters or collections may be addressed to either of the above named.

ISAAC BURK, our best authority on Philadelphia ballast plants, and long prominently connected with the botanical work of the Philadelphia Academy of Sciences, died March 29th, in his 77th year. On account of poor health and the need of out-door employment he had charge for over thirty years of a *Philadelphia Ledger* route. He was a student of botany from boyhood, and all his leisure time was occupied in making collections and in study of natural science. He arranged a large part of the collection belonging to the Philadelphia Academy, of which he was a life member. In 1880 he presented his private collection to the Biological Department of the University of Pennsylvania. It is there maintained as a separate collection, and is specially rich in local and ballast plants. He was the author of a series of articles on the flora of Fairmount Park, published in the *Ledger* just before the Centennial. Several of his papers also appeared in the *Proceedings of the Phil. Acad.* Dr. Wm. H. Burk, botanist of the Peary expedition is his son.

In 1890, Prof. Fr. Elfving, of Helsingfors, gave a communication on physiological action at a distance, showing a remarkable kind of movements that took place in the sporangium-bearers of Phycomyces, when exposed to the influence of certain bodies placed in their neighborhood, such as metals of different kinds, etc. Iron attracts the growing sporangium-bearers very distinctly; less noticeable was the effect of zinc and aluminium; gold, silver, nickel, lead, and copper, etc., had no effect, but roots of several common plants, *Vicia*, *Phaseolus*, *Pisum*, and others, as well as sealing wax, rosin, and smooth paper, had a very marked effect, attracting the sporangium-bearers more or less. The filaments mutually repulsed one another. Elfving thought that electricity probably was active here. Prof. Errera, of Brussels, has now[2] given a new explanation of these remarkable movements, namely, that they are due to hydrotropism, and his facts are the following: China clay, which is very hygroscopic, attracts energetically, but china exhibits no attraction; agate, which is very hygroscopic,[3] strongly attracts the filaments, while rock-crystal does not exhibit any effect, owing to its non-hygroscopic properties. The sporangium-bearers, being thus a fine reagent on hygroscopic power, were used by Errera to test that property on camphor; this substance is, in fact, hygroscopic.—Bay.

The following extract from the annual report of the President of Harvard University is of interest to botanists: "On the death of Dr. Watson, Curator of the Herbarium from 1874 to 1892, Benjamin Lincoln Robinson, Ph. D., was appointed Curator, and in August last Mr. Henry E. Seaton, who had been instructor in botany and Curator of the Herbarium at the University of Indiana, was appointed Assistant Curator for the current academic year. It was also possible to appoint more assistants than ever before. The liberal gifts to the Herbarium for immediate use, and the good income from Professor Asa Gray's copyrights ($2,817.33 in 1892) permit this increase of expenditure at the Herbarium. The result has been a great increase of the work accomplished, over 20,000 plants having been added to the collection during the year. Moreover, it has become possible for the Curator to resume work on the Synoptical Flora of North America, the great work first interrupted by the death of Dr. Gray, and then by the death of Dr. Watson. In the present debates about botanical nomenclature, it will be the policy of the Herbarium to act a conservative part; no serious departure will be made from the nomenclature thus far used in the Herbarium and in the published works of its Director and Curators."

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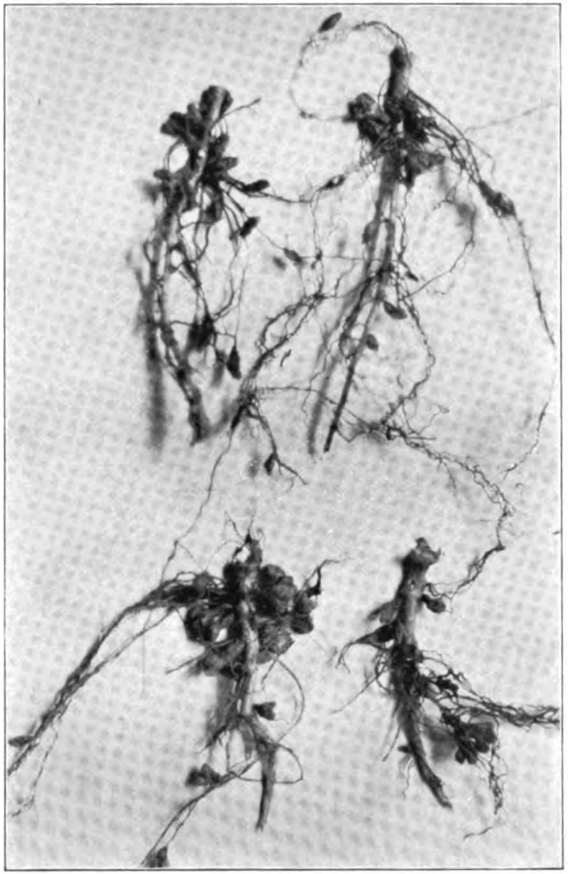
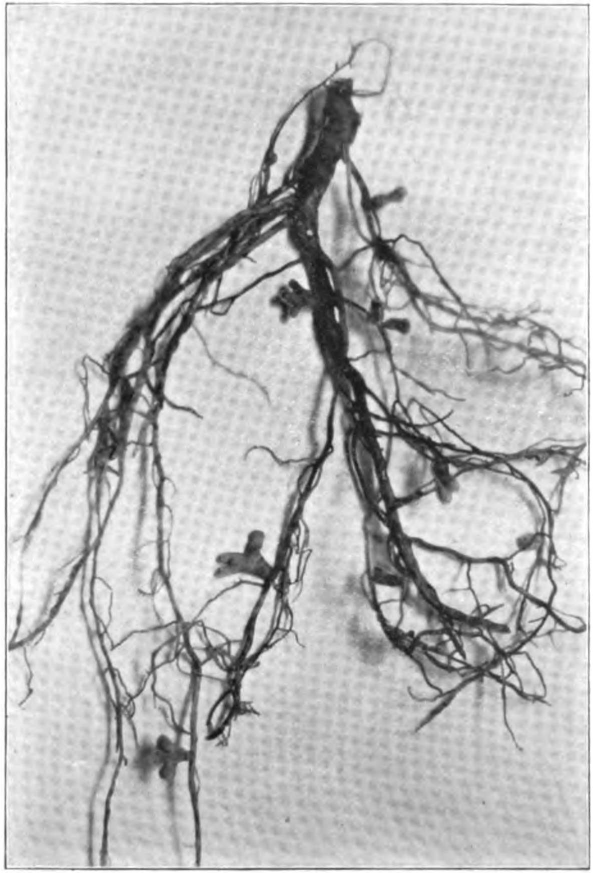
[1] Ueber physiologische Fernwirkung einger Koerper. Helsingfors, 1890, 2 plates.

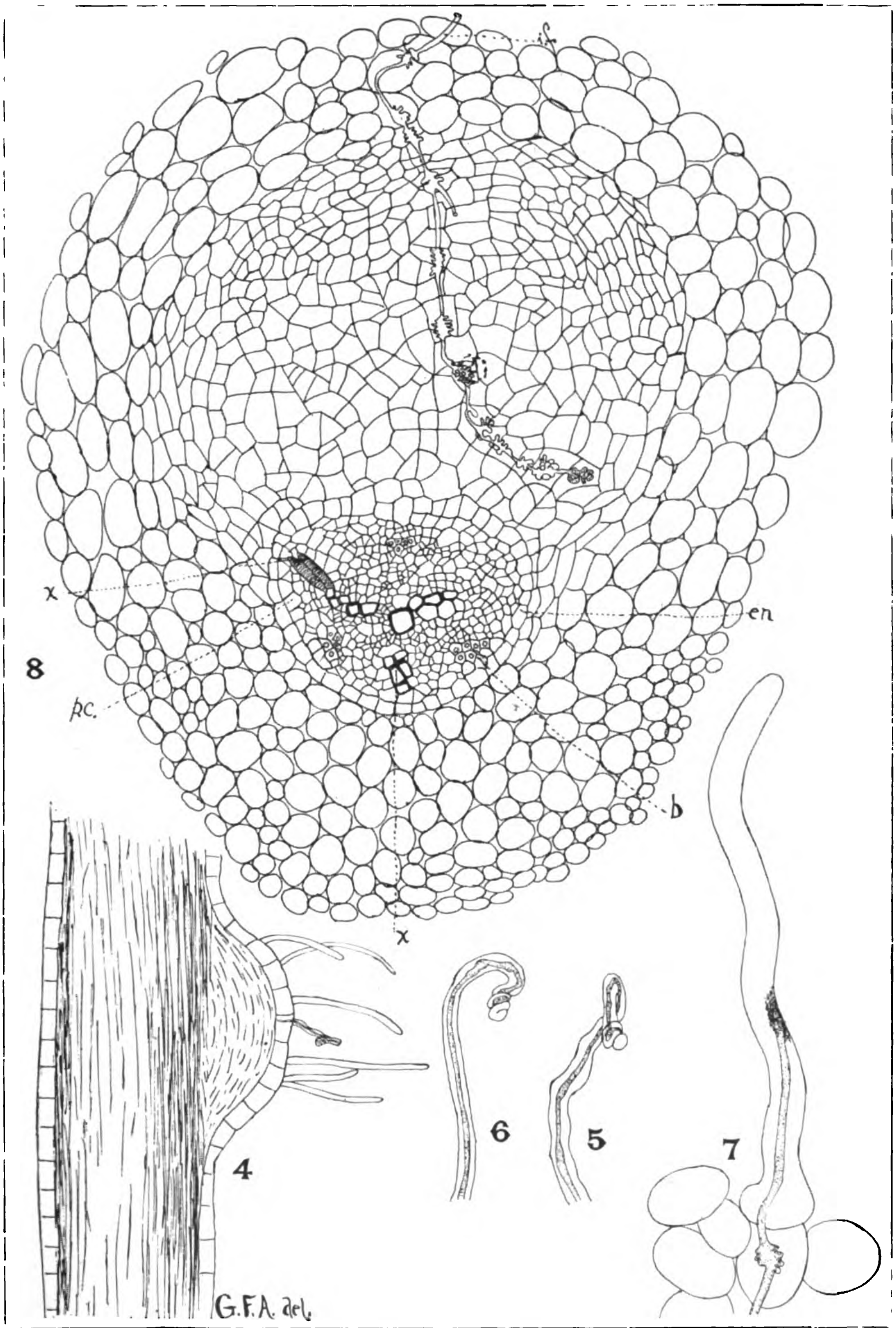
[2] On the cause of physiological action at a distance. Annals of Botany, vi, 373 (1892).

[3] Jhmori: Weidemann's Annalen, 1887.





ATKINSON on LEGUMINOUS TUBERCLES.



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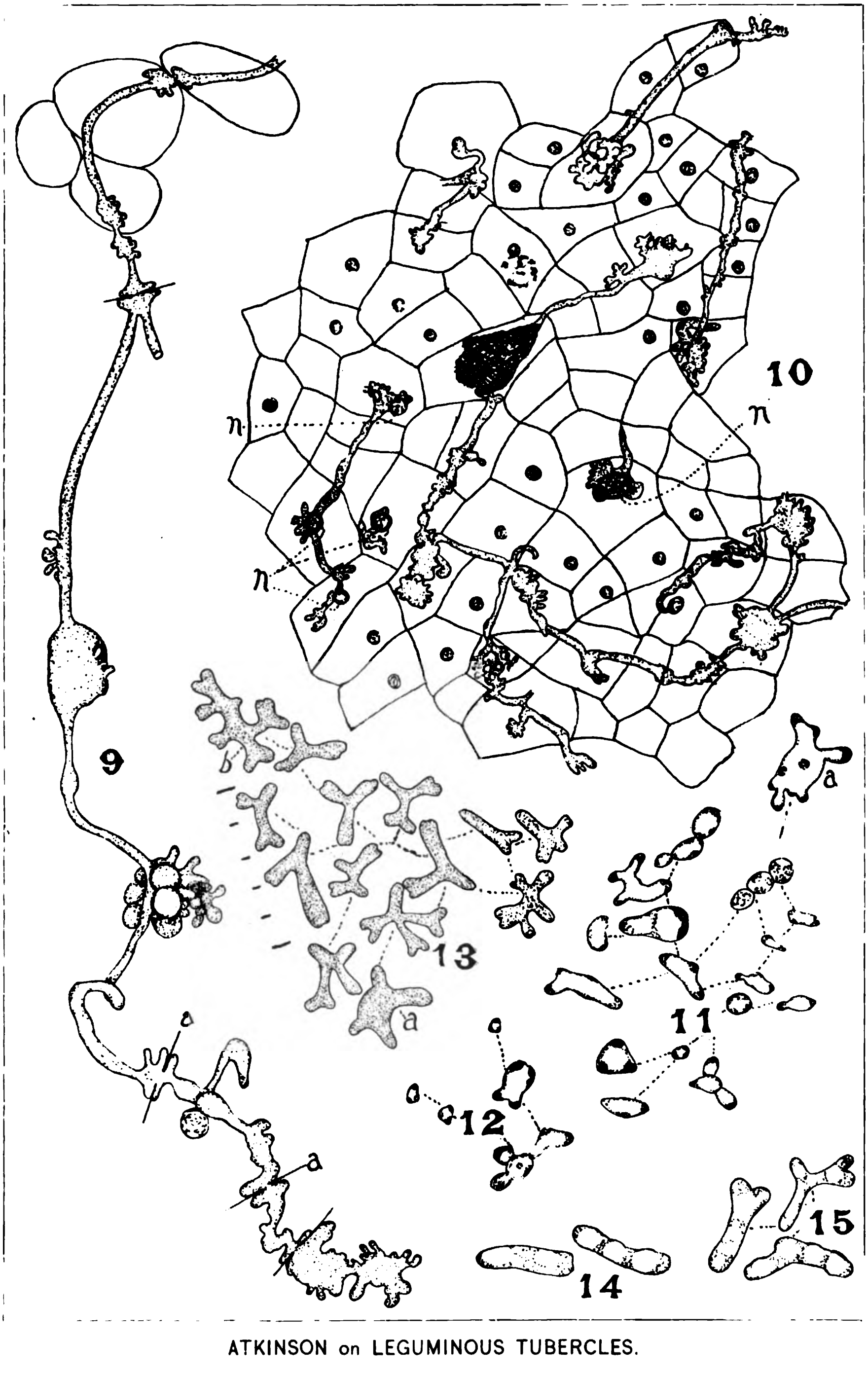

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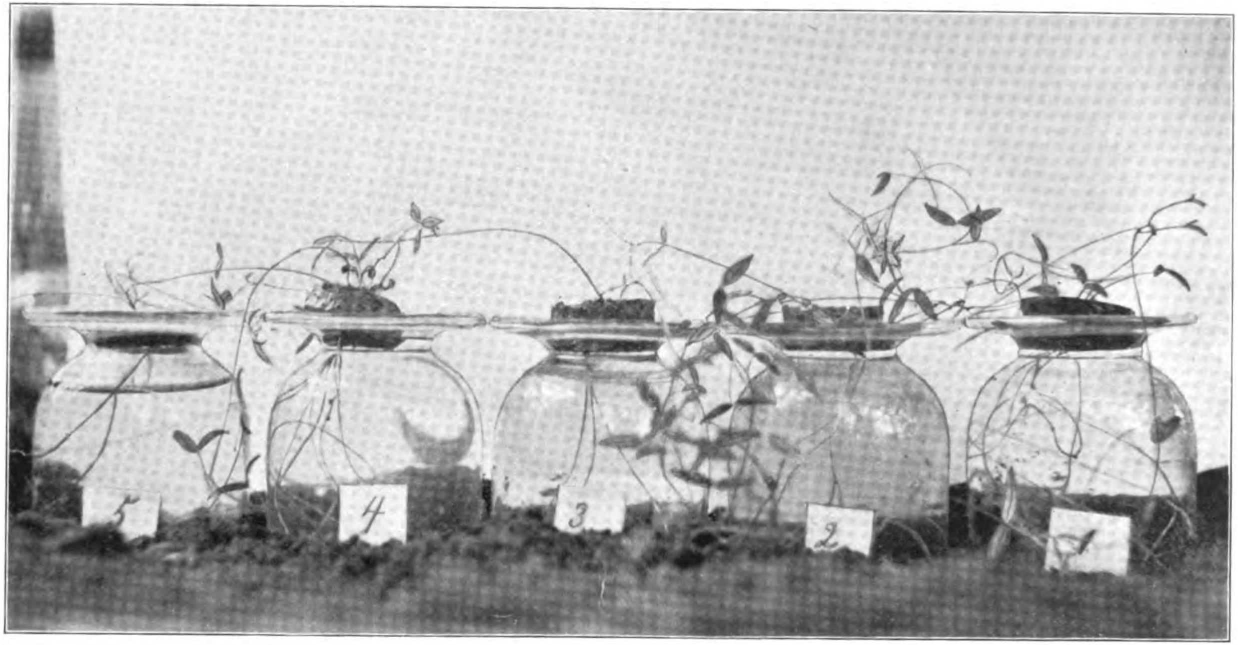

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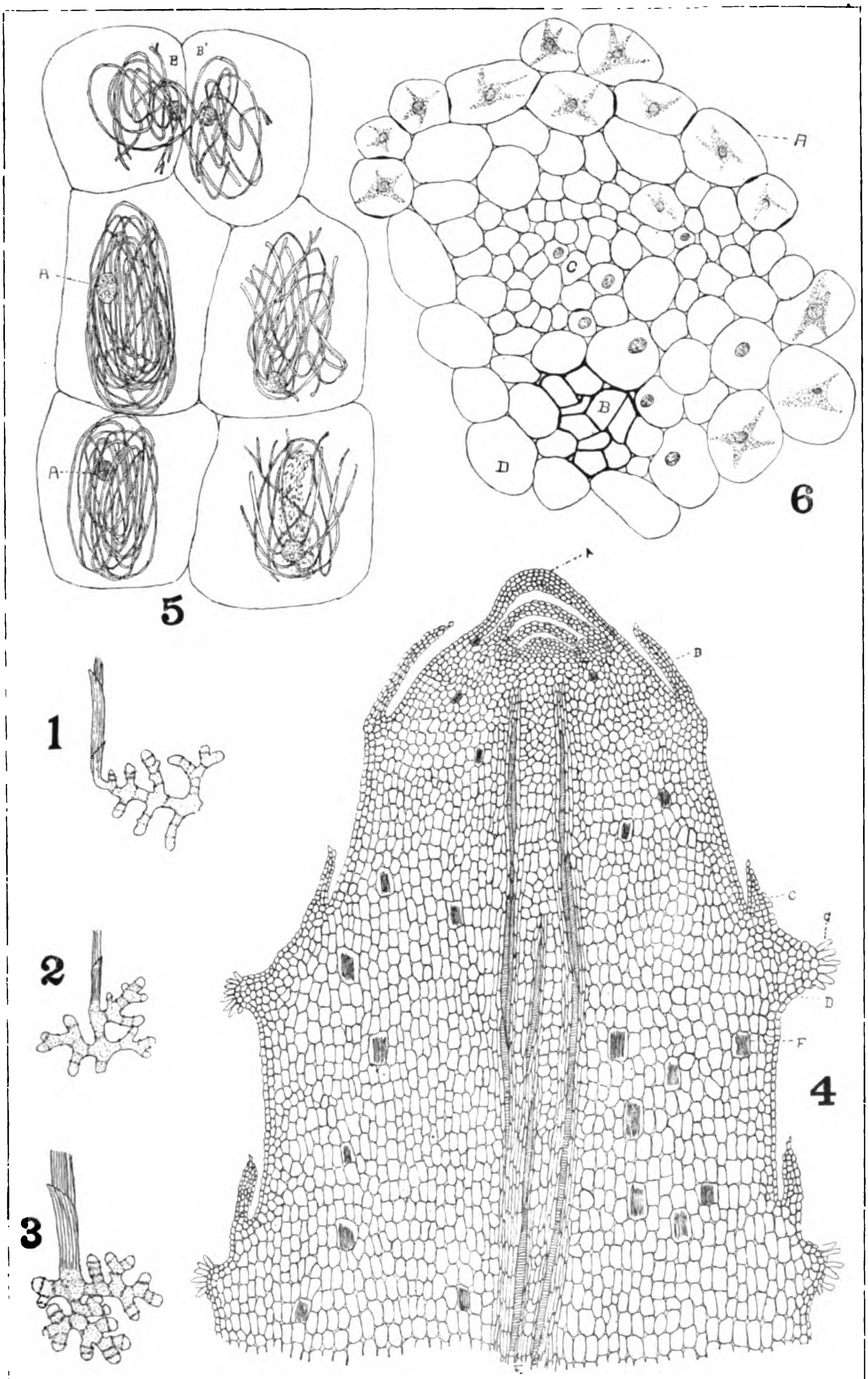
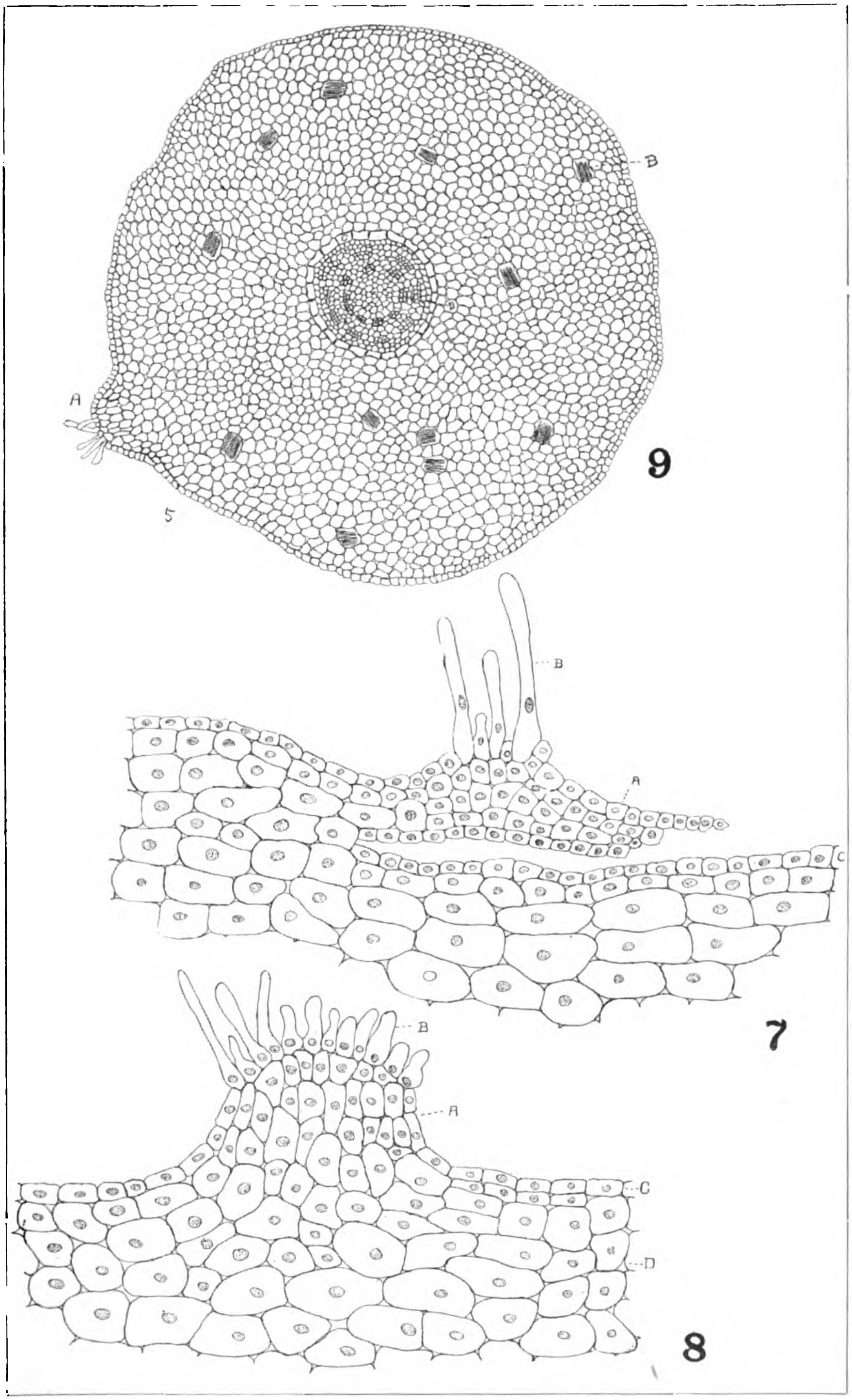
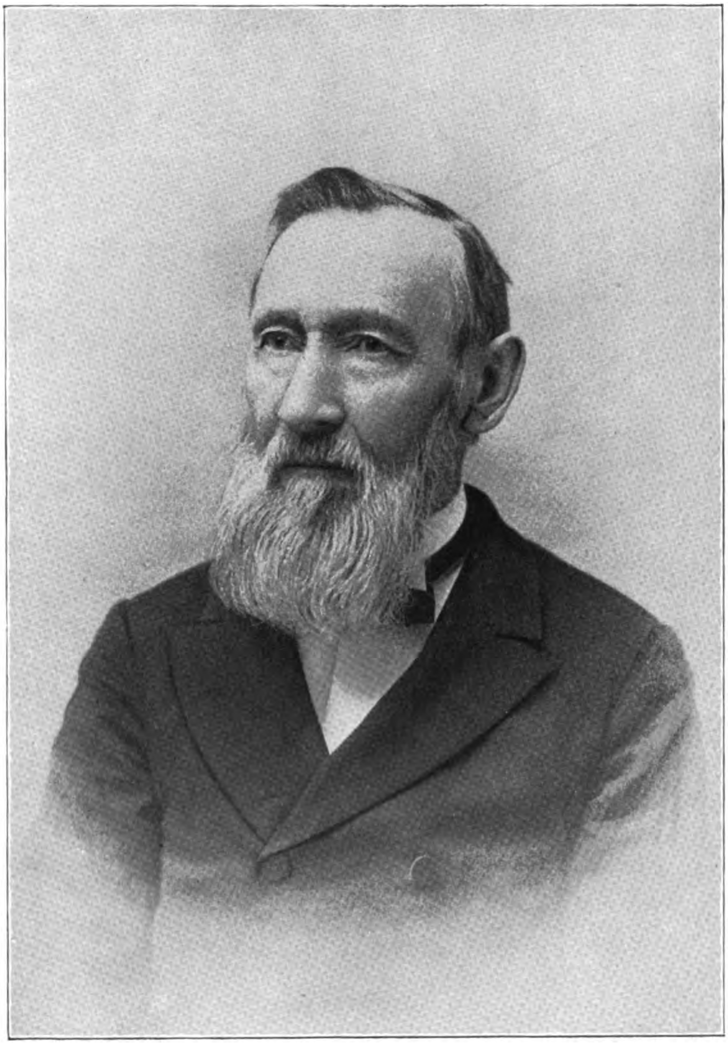


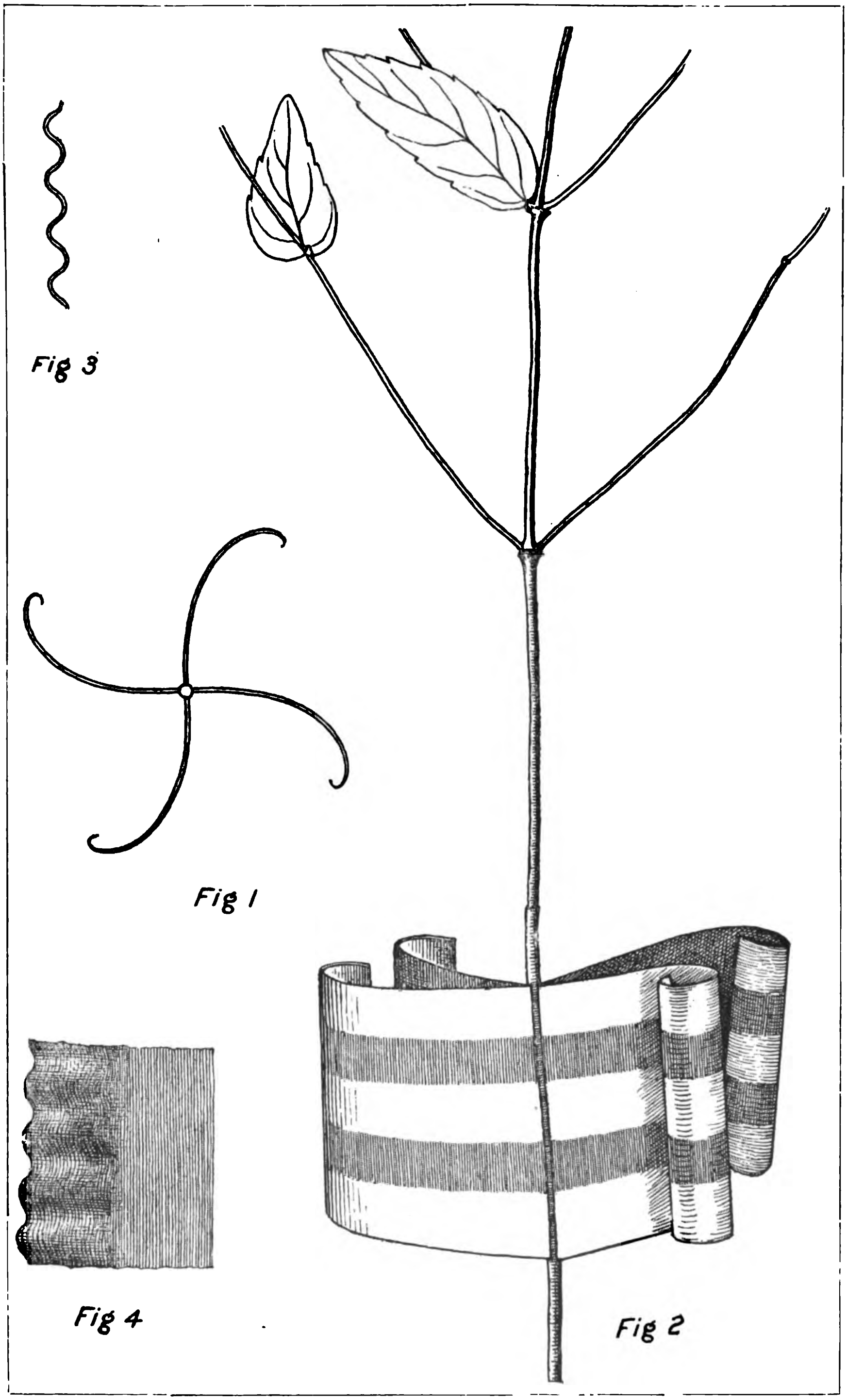
THOMAS on CORALLORHIZA.



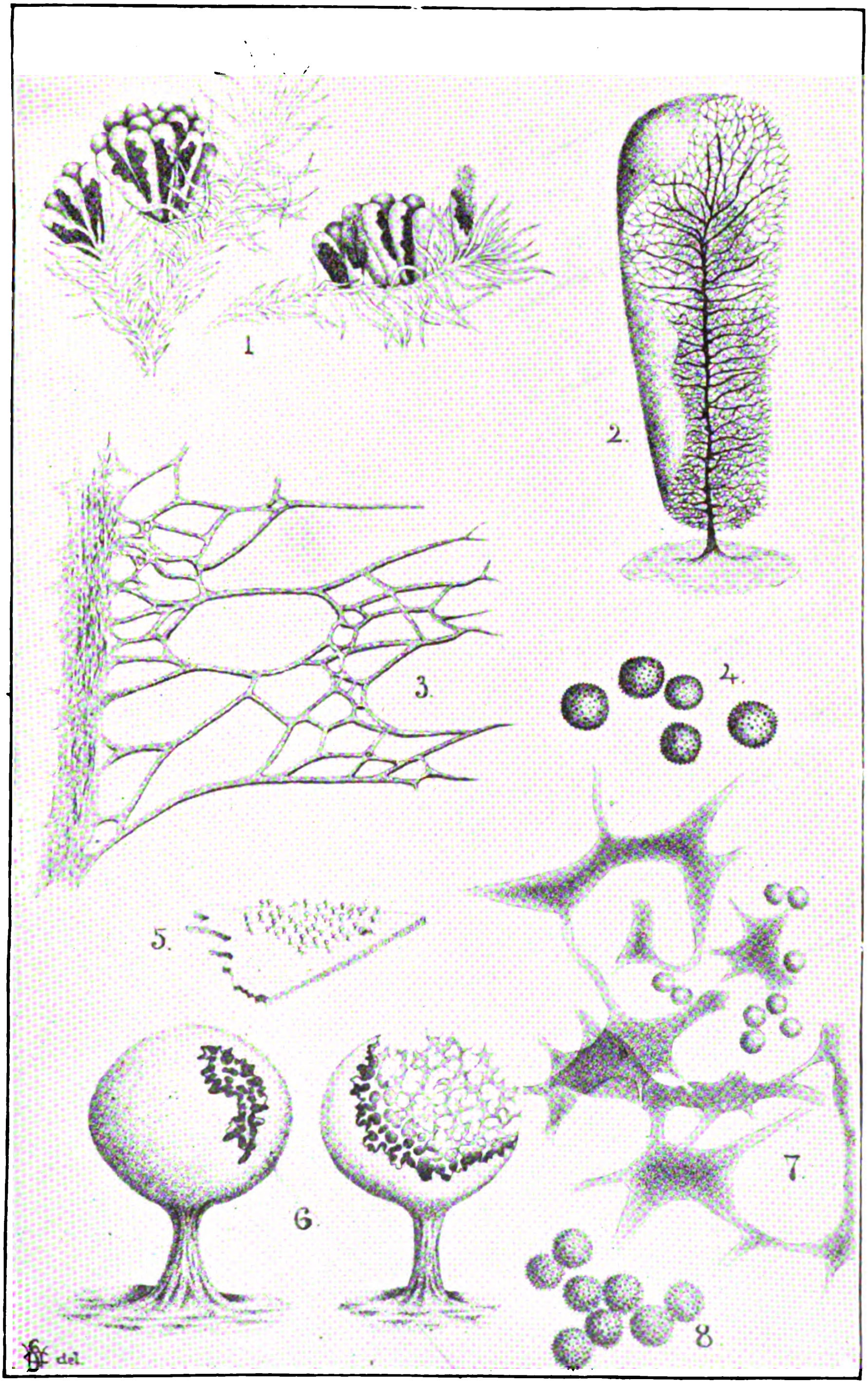
THOMAS on CORALLORHIZA.



GEO. VASEY.



WARD on DITTANY.



STURGIS on MYXOMYCETES.

BOTANICAL GAZETTE

JUNE, 1893.

Undescribed plants from Guatemala. XI.

JOHN DONNELL SMITH.

WITH PLATES XXI–XXIII.

This paper includes descriptions contributed by various botanists, who are kindly assisting in the elaboration of the plants of the series.

Capparis Heydeana (Subgen. CYNOPHALLA Eichl. in Fl. Brasil.)—Glabrate, axils eglandular: stipules minute; leaves obovate-oblong to elliptical-oblong ($4–5 \times 1\frac{1}{4}–1\frac{3}{4}^{in}$), acuminate, midrib excurrent, base acute, canaliculate petiole an inch or more long: flowers from axils of reduced leaves composing terminal short racemes; pedicels stout, exceeding petioles, apex incrassate: sepals oblong ($8–10^{l}$), obtuse: petals obovate-spatulate ($2\frac{1}{4}–2\frac{1}{2} \times \frac{3}{4}^{in}$): stamens scarcely as long, 6; carpophore equalling petals, ovary 2-locular: glands of disc distinct, triangular.—Remarkable in the genus by the large petals and in the sub-genus by the few stamens. Prof. Radlkofer, to whom this plant was submitted for comparison, calls attention to the accordance of its anatomical characters with those of *Cynophalla;* he observes the presence of soluble crystals in the cells of the upper and lower epidermis of the leaf such as occur in *C. Cynophallophorus* L., *C. polyantha*, Tr. et Planch. and other allied species (cf. Vesque in Ann. sc. nat. 6^{me} Sér. 103, t. xiii).—Tree $30–45^{ft}$ high, mountains overhanging Lake Ayarza, Depart. Jalapa, alt. $8,400^{ft}$, Sept. 1892, Heyde & Lux, (ex Pl. Guatemal. qu. edid. J. D. S. 4,112).

Xylosma Quichense.—Arborescent ($10–15^{ft}$), unarmed, pubescent: leaves oblong-elliptical ($3\frac{1}{2}–5 \times 1–1\frac{1}{2}^{in}$), contracted-acuminate, base obtuse, upper surface shining and excepting nerves smooth, incurved-serrate, shortly petiolate: racemes solitary or 2–3-fasciculate, simple or paniculate, 3–6 times

exceeding petiole, scaly bracteose, 10–20-flowered, pedicels bracteolate above base, bracteoles linear-lanceolate (1–2'): sepals 4–6, in anthesis broadly ovate, at length elliptical-oblong (2'), glabrous, naked: glands obpyramidate, subconnate in a crenate cupuliform annulus: stamens numerous (20–35), not exceeding sepals: pistillate flowers and berries not seen.—*X. spiculiferum* Tr. et Planch., the only other species described with unisexual distinctly racemed and large-sepalous flowers, differs by spines, leaves ovate to orbicular-cordate, ciliate sepals, longer stamens, etc.—San Miguel Uspantán, Dept. Quiché, alt. 6,000ft, Mch. 1892, Heyde & Lux (ex Pl. cit. 3,066).

Var. **subalpina.**—Glabrous excepting racemes, branchlets red and glandular-lenticellate: leaves ovate-elliptical, shorter, thicker: bracteoles colored, semi-sheathing, glandular-denticulate, subequalling pedicels.—Forests near El Jute, Depart. Quiché, alt. 10,000ft, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,064).

ARENARIA ALSINOIDES Willd., var. **ovatifolia.**—Leaves pilose, ovate-acuminate, base rounded or cuneate, subsessile: petals twice larger (5') than sepals: seeds numerous (18–30), punctulate, red.—Volcan de Agua, Dept. Zacatepequez, alt. 10,000ft, June 1892, Dr. W. C. Shannon, U. S. A., (ex. Pl. cit. 3,635).

Stigmaphyllon cordatum Rose.—Climbing shrubs: leaves ovate to oval, 1½ to 3 inches long, deeply cordate at base with sinus open, rounded or with a short acumination, glabrous on both sides, minutely reticulated; petioles often elongated, biglandular at top: inflorescence a simple or compound umbel; peduncles 4 to 7 inches long; rays either wanting or sometimes 4 inches long; pedicels 6 to 12 lines long, bibracteate below the middle; calyx 5-lobed, 8-glandular: petals oval, obtuse with denticulate margins: fertile stamens 6; styles 3; stigmas with triangular dilation: samaræ generally 3, 15 lines long, oblong, obtuse, dorsal side toothed 2 or 3 lines above the base without lateral crests.—Depart. Guatemala, alt. 5,000ft, Mch. 1892, Heyde & Lux, (ex Pl. cit. 3,267).

Oxalis clematodes.—Fruticose; branches long-reclinate, fuscous, pilose, extremities cano-villose: petioles incrassate-articulate at barbate axils, twice exceeding leaves: leaflets ternate, subsessile, obovate (6–11 × 4–7'), emarginate or entire,

the lateral oblique, the terminal one somewhat larger, pilose, canescent beneath: peduncles filiform, chiefly twice exceeding petiole, cymes 2–5-flowered, pedicels not geniculate: sepals oblong, apex rounded: petals thrice longer (7'), obtuse, yellow: filaments connate above ovary, edentate, the larger ones scabrid: capsule cano-villose, cells uniovulate or occasionally two-ovulate.—The most nearly related species, *O. pentantha* Jacq., differs by a less shrubby habit, pinnately trifoliolate leaves, acute sepals, dentate filaments, 3–4-ovulate cells, etc.—San Miguel Uspantán, Depart. Quiché, alt. 6,500^{ft}, April, 1892, Heyde & Lux, (ex. Pl. cit. 2,992.)

Wimmeria cyclocarpa Radlk.—Rami hornotini, pedicelli, petioli foliaque (subtus densius, supra sparsim) pubescentia; folia majuscula, petiolo 8^{mm} adjecto circ. 7^{cm} longa, 3^{cm} et ultra lata, elliptico- vel ovato-lanceolata, acuta, vel abbreviata obtusa, immo suborbicularia, minutim glanduloso-serrulata, reti venarum pellucido laxiore instructa, pallide viridia; dichasia axillaria, quam folia breviora, 7–15-flora; fructus suborbicularis, vix brevior quam latus, diametro circ. 2^{cm}, basi et apice excisus, alis membranaceis, styli brevis apice 3-stigmatosi reliquis coronatus, e roseo pallescens.—OBSERV. Intermedia quasi inter W. pubescentem Radlk. (in Sitzungsber. k. bayer. Acad. 1878, p. 378) et W. confusam Hemsl. (W. pallidam Radlk. l. c. p. 379) et quidem quoad characteres anatomicos quoque: W. pubescens hypodermate fere continuo ad paginam foliorum superiorem instructa est, W. cyclocarpa supra venas tantum, W. confusa nullo. Ab una alteraque differt cellulis crystallophoris crystalla singula magna, ut in W. discolore et concolore, nec globoso-agglomerata foventibus. Insignis quoque stomatibus quodammodo elevatis. Uti omnes Wimmeriæ species, quam rem 1885 observavi, excellit cellulis liberi quibusdam (et ramorum et foliorum) materia elastica fœtis, quæ materia *kautchouk* certe affinis est et illam *Parameriæ* a me olim (in Sitzungsber. k. bayer. Acad. 1884, p. 515) descriptam in mentem revocat. Similem materiam inveni in *Tiliacearum* (*Prockiearum*) genere monotypico "*Plagiopteron* Griff." (*P. suaveolens* Griff.—in tabula *P. fragrans* ab autore appellatum—nunc *Sapindaceis* nunc *Malpighiaceis* nunc *Euphorbiaceis* affine dictum, cf. Walp. Rep. v. 370, Kurz For. Fl. Brit. Burma I. 172), in cortice, corona medullari, foliis florisque partibus. Deest hæc materia in reliquis *Prockiearum* generibus "*Prockia*" et "*Hasseltia*." Deest quoque in genere

quam maxime *Wimmeriæ* affini, sed Asiæ incola (ex Forbes et Hemsley in Jour. Linn. Soc. XXIII. 125 monotypico) quod Hooker filius "*Tripterygium*" nominavit (T. Wilfordii Hook. f.). In quibusdam vero a nonnullis inter *Celastrineas* adscitarum *Hippocrateacearum* stirpibus taliscumque materia obvia est, uti nuperrime D. Solereder observavit (ex. gr. in Salacia micrantha Peyr. et in truncis quibusdam a H. Schenck sub. n. 347^{b}, 519 et 632 missis, *Salaciæ* et *Hippocrateæ* generibus, ut videtur, adscribendis (quorum unus, n. 632, in Engl. & Prantl Pflanzenfam. a D. Niedenzu sub *Malpighiaceis*, Fig. 37 A et B, depictus est). Suo loco D. Solereder ipse hanc rem (nec a Th. Loesener sub *Hippocrateaceis* in Engl. & Prantl Pflanzenfam. 1892, nec a H. Schenck in Anat. Lian. II, 1893 indicatam) fusius traclabit. (L. Radlkofer.)—Tree 30^{ft} high, slopes of the volcano Jumaytepeque, Depart. Santa Rosa, alt. $6{,}000^{ft}$, Sept. 1892, Heyde & Lux (ex Pl. cit. 3,708).

RHAMNUS CAPREÆFOLIA Schlecht., var. **discolor**.—Leaves somewhat coriaceous, upper surface excepting veins glabrous, the lower cano-velutinous.—Coban, Dept. Alta Verapaz, alt. $4{,}300^{ft}$, Aug. 1885, von Türckheim, (ex Pl. cit. 710); distributed as typical. No. 3,051 of the series is more true to the description.

THOUINIA ACUMINATA Watson, var. **pubicalyx** Radlk.—Calyx pilis adpressis dense cano-pubescens.—A tree $25–30^{ft}$ high; mountains around Lake Ayarza, Dept. Jalapa, alt. $8{,}800^{ft}$ Sept. 1892, Heyde & Lux, (ex Pl. cit. 3,955); Volcan Jumaytepeque, alt. $6{,}000^{ft}$, Nov. 1892, Heyde & Lux (ex Pl. cit. 4,122).

HELODISCUS ARGENTEUS Maxmw. (*Spiræa argentea* Mutis), var. ? **bifrons** Focke.—The genus *Helodiscus* is distinguished from *Spiræa* by its indehiscent carpels. This important character is associated with a peculiar habit, and it will therefore be advisable to keep the two genera separate. The North American *H. discolor* Maxmw. (*Spiræa discolor* Pursh, *Sp. ariæfolia* Sm.) is a very variable plant, and its subspecies *dumosa* Wats. looks like a different species approaching the *H. argenteus* by its narrow leaves. In the typical *H. argenteus* the leaves are silky above, but very likely this character is not constant. In our plant, as in other Guatemala specimens that I have seen, the upper surface of the leaves is glabrous (var. *bifrons*). It has larger flowers than

H. discolor, and narrow cuneate leaves tapering into the short stalk. After all it seems to be more natural to put it under *H. argenteus* than under *H. discolor;* but it may be doubted if true limits exist between these two pretended species. The specimen n. 3,034 is a very large one, and was gathered from a bush 3–4 yards high. The plant represented in H. B. K. Nov. gen. Amer. VI. tab. 562, as well as Guatemala specimens in the Berlin Herbarium, are very much smaller. (W. O. Focke).—Nebáj, Depart. Quiché, alt. 7,000ft, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,034).

RUBUS TRILOBUS Moç. et Sessé, var. **Guatemalensis** Focke.—Branches, petioles and under surfaces of the young leaves slightly pubescent, not so hairy as in the typical plant. Leaves broader than in type, slightly three-lobed; base of the terminal lobe often broader than its length, the lateral ones very short or indistinct.—Volcan de Agua, alt. 8,000ft, June 1892, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 3,631).

Rubus superbus Focke.—Rami suppetunt duo florentes.—Rami cum petiolis tomentoso-pubescentes, sparsim et minute aculeati. Stipulæ petiolares parvæ filiformes. Folia ternata, foliola omnia petiolulata, subcoriacea, crebre et argute serrata, utrinque in nervis pilosa, ceterum glabriuscula, supra nitida, subtus opaca; foliolum terminale ellipticum, longe acuminatum, basi rotundatum, in utroque latere 8–10-nervia; lateralia paullo minora similia. Inflorescentia sat ampla, elongata, inferne folio uno ternato et altero simplici prædita, subracemosa vel ramulis inferioribus trifloris paniculata. Rhachis cum pedunculis tomentoso-hirsuta, minute aculeata; bracteæ lanceolatæ, parvæ, tomentosæ. Pedicelli sepalis multo longiores, laterales in ramulis trifloris approximati, sed non oppositi. Flores spectabiles; sepala ovata, concava, utrinque cano-tomentosa. Petala magna, obovata, unguiculata, sepalis duplo vel triplo longiores. Stamina numerosa, stylos superantia, post anthesin patentia. Carpophorum hirsutum; carpella numerosa, styli apice clavati stigmate magno coronati.—The specimens were gathered in an old cornfield, and their growth may therefore have been more luxuriant than it would have been in other places. The size of the flowers is much greater than in any of the allied species, their diameter in a dried state being about one and one-half inches. Notwithstanding the imperfect knowledge of the plant there can be no doubt that it is sufficiently distinct from all described

species. Among the brambles (*Eubatus*) of Mexico and Central America *R. fagifolius*, *R. scandens*, *R. Schiedeanus* and *R. coriifolius* bear their flowers in compound racemes; *R. adenotrichos*, *R. Bogotensis* and allied forms are distinguished by their copious glandular bristles; *R. sapidus* may be easily distinguished by its short racemose inflorescence and prickly peduncles; in *R. humistratus* the flowers are usually solitary; *R. floribundus* has soft tomentose leaves; *R. Liebmannii*, *R. tiliæfolius* and *R. Uhdeanus* have small flowers and very hairy leaves. (W. O. Focke.)—San Miguel Uspantán, alt. 6,000ft, Apr. 1892, Heyde & Lux, (ex Pl. cit. 3,326).

Rubus poliophyllus Focke.—(*R. coriifolius* Focke in Enumer. Pl. Guatemal. qu. edid. J. D. S. Part. II. p. 19; non Liebm.)—Rami teretiusculi, tomentoso-puberuli, aculeis e basi lata compressa recurvis armati, florentes et terminales et laterales. Folia inferiora quinata vel subquinata, superiora ternata, suprema sæpe simplicia; stipulæ petiolares, parvæ, filiformes. Foliola omnia petiolulata, subcoriacea, mollia, argute serrulata, superne stellulato-tomentella, subtus cano-tomentosa, in utroque latere 8–10-nervia; terminale ovato-ellipticum vel oblongum, breviter acuminatum, lateralia minora similia. Inflorescentia mediocris, multiflora, divaricata, paniculata; rhachis ramuli pedicellique cano tomentosi, aculeis parvis raris setisque glanduliferis sparsis longis interdum quoque brevibus intermixtis muniti. Ramuli inferiores axillares, erecto-patentes, racemoso-pluriflori, sequentes bracteolis trifidis tomentosis suffulti, patentes, supra medium 3–7-flori, supremi bracteis simplicibus lanceolatis muniti, approximati, vulgo uniflori. florem terminalem superantes. Sepala ovata, breviter mucronata, utrinque tomentosa, post anthesin patentia. Petala (mediocria vel parva ?), decidua, alba. Stamina numerosa, stylis, ut videtur, æquilonga. Carpophorum pilosum; carpella sat numerosa, glabra. Fructus hemisphærici, nigri, ex acinis ca. 20 compositi.—This is the same species that I supposed at first sight to be a variety of *R. coriifolius*. Having seen more specimens I have no doubt now that it is quite different; in *R. coriifolius* all the branchlets of the panicle bear their flowers in racemes and not in cymes. It is much more difficult to distinguish the new plant from *R. Liebmannii* and *R. Uhdeanus;* its leaves, however, are much more tomentose than in the allied species. *R. Liebmannii* has a short drooping panicle and pink petals, *R. Uhdeanus* a

narrow elongated inflorescence and oblong fruits with very numerous grains. The leaves of *R. poliophyllus* resemble those of *R. floribundus* H. B. K., which has, however, a dense panicle, short pedicels and no glandular bristles. The knowledge of all these species is imperfect, and they require a more careful examination in their natural stations. As far as we can judge from the dried branches, it would be quite unnatural to put them under the same specific name. The specimens of this plant are nearly all alike; in no. 2,535 the pedicels bear besides the scattered long glandular bristles a quantity of short-pedicelled glands. In the Berlin Herbarium I have seen a specimen of this plant from Mexico (Otlamaltatle, Depart. Zacualtip, Prov. Hidalgo; leg. Seler sub no. 879). (W. O. Focke.)—San Rafael, Depart. Zacatepequez, alt. 6,500^{ft}, April 1890, J. D. S., (ex Pl. cit. 2,141); same locality, Febr. 1892, J. D. S., (ex Pl. cit. 2,533); Volcan de Fuego, alt. 5,500^{ft}, March 1892, J. D. S., (ex Pl. cit. 2,535).

CLIDEMIA CYMIFERA Donnell Smith, Botan. Gaz. XIV. 25: Cogn. in DC. Mon. Phan. VII. 1,017.

EXPLANATION OF PLATE XXI.—Fig. 1, flowering branch. Fig. 2, unopened flower. Fig. 3, petal. Fig. 4, vertical section of flower with petals removed. (Fig. 1 is natural size; the others are variously magnified.)

CUPHEA UTRICULOSA Kœhne, var. **Donnell-Smithii** Kœhne.—Differt a var. α et β foliis angustis, in ramis sterilibus linearibus, in fertilibus lineari-lanceolatis, præcipue vero calyce intus infra stamina in nervis omnibus villosiusculo. Flores ceterum ut in var. α; rami ut in var. Panamensi Hemsl. vestiti; fructus calycem æquans, quare stylus brevis totus exsertus.—Primavera, Depart. Sololá, alt. 800^{ft}, July 1891, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 403).

Mallostoma Shannoni.—Cespitose: stems prostrate, rooting at nodes, tetragonal: ovate stipules 3-setose or the lateral bristles replaced by glandular teeth, short flat petioles decurrent in a pubescent wing, leaves oval to elliptical-oblong ($2\frac{1}{2}$–4×1–2^{in}), conterminously obtuse or acute, coriaceous, venation obscure, like stems rubro-punctate, revolute margin and midrib beneath pubescent: flowers terminal, solitary, 4-merous, 5^{l} long: calyx-lobes triangular-lanceolate (1^{l}), equalling turbinate tube and ebracteate peduncle, truncate sinuses glandular-denticulate: lobes of infundibuliform corolla somewhat shorter than tube, ovate-oblong, scaly-pubescent within, throat naked: filaments short ($\frac{1}{2}^{l}$): style a third shorter than

tube, large stigma subglobose: capsule obovate (2^{l}), more or less free at apex, 8-costate, loculicidal at apex, septicidal at base; seeds 8–20, compressed, roundish ($\frac{1}{3}^{l}$), finely punctate, black and shining.—Nearest to *M. setosa* Benth. et Hook., and especially to the form or var. (*Arcytophyllum setosum* Schlecht. in Linnæa, XXVIII, 489).—"Forming a carpet-like turf," Chichoy, Depart. Chimaltenango, alt. $9,000^{ft}$, March 1892, W. C. Shannon, Asst. Surg. U. S. A., associate of the Intercontinental Railway Commission, whose interesting collections along the lines of the surveys have been turned over to me for determination and distribution by Capt. M. M. Macomb, U. S. A., Engineer in charge, (ex Pl. cit. 371); San Miguel Uspantán, alt. $7,500^{ft}$, April 1892, Heyde & Lux, (ex Pl. cit. 3,176).

Hoffmannia rotata.—Stems above obtusely tetragonal and ferruginous-furfuraceous: leaves opposite or 3–4-verticellate, elliptical-lanceolate or oblanceolate (4–7×1–$1\frac{1}{2}^{in}$), acuminate, more or less long-attenuated to short petiole, smooth above, paler and puberulous beneath with furfuraceous nerves: peduncles single in upper axils or pluri-fasciculate at lower nodes, filiform ($\frac{3}{4}$–2^{in}), cymes 6–15-flowered, axes slender: calyx urceolate (1^{l}), shorter than pedicel, teeth obtuse, sinuses glandular-appendaged: corolla rotate (4–5^{l} in diam.), tube very short ($\frac{1}{2}^{l}$), lobes oblong: filaments a half or two thirds as long as anthers: ovary 2-celled, connate-lobed stigma subequalling anthers: berry globose ($2\frac{1}{2}^{l}$), crowned with incrassate limb, seeds red.—*H. pedunculata* Swz., related by foliage and corolla, is distinguished by merely opposite leaves, solitary peduncles, subsessile anthers, oblong berries and black seed.—A bush 3–6^{ft} high; damp forests near San Migual Uspantán, alt. $7,000^{ft}$, April 1892, Heyde & Lux, (ex Pl. cit. 3,169 and 3,174).

Guettarda macrosperma (§ MATTHIOLA Benth. et Hook.) —Arborescent, younger parts flavo-sericeous: stipules round-ovate (2^{l}), filiform-caudate, the interior toward base appendaged with intermixed subulate glands and white hairs: leaves ovate ($2\frac{3}{4} \times 1\frac{1}{2}^{in}$), the younger rhomboid or obovate, sparsely pilose above, glabrate beneath except venation and with the the 6–7 costal nerves and transverse veins conspicuous: peduncles shorter than leaves (8–16^{l}), velvety; flowers of twice bifid cymes crowded, 5–6-merous: calyx velvety, shortly tubu-

lar ($1\frac{1}{2}'$), exceeding linear bract, thrice surpassing ovary, truncate: tube of sericeous corolla four times longer, thrice exceeding oval lobes: anthers narrowly linear ($1\frac{1}{2}'$): style glabrous: drupe obovoid-oblong ($6–7 \times 3–4'$), thick putamen angulate, 3–4-celled.—Santa Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, (ex Pl. cit. 3,160).

Parathesis calophylla.—Except upper face of foliage everywhere densely ochraceous-tomentulose: leaves elliptical-lanceolate ($6–8 \times 2–2\frac{1}{4}^{in}$), conterminously attenuate, tapering into canaliculate long ($15 \times 18'$) petiole, 15–20 costal nerves uniting within the revolute margins, evenulose, nigro-punctate beneath the tomentum: panicles chiefly axillary, subequalling leaves, broadly pyramidate, loose, axes stout and spreading; flowers exceeding pedicels, few-fasciculate at apex of secondary or tertiary branches: calyx-segments elongate-triangular ($1'$): the corolline narrowly linear ($3\frac{1}{2} \times \frac{3}{4}'$), albo-lepidote within: anthers nearly equalling filament ($1\frac{1}{4}'$), obtuse, affixed at base, dehiscing throughout: ovary tomentose, tapering into style: berry not seen.—Other species with distinctly compound panicles may be distinguished either by glabrity or by minute calyx.—Tree 40–50^{ft} high with a slender trunk, the glossy upper surface of the leaves remaining green in exsiccate specimens, and contrasting elegantly with the dark-brown undersurface.—San Miguel Uspantán, alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, (ex Pl. cit. 2,909).

PARATHESIS MICRANTHERA.—In describing this species, vol. XIV. p. 27, and likewise in its subsequent notice, vol. XVIII. p. 4, the specific name was inadvertently written *micrantha* instead of *micranthera.*

Ardisia venosa Masters.—Arbuscula, foliis crassiusculis ellipticis vel obovato-oblongis integris, basi in petiolum latum brevem angustatis, apice breviter abrupteque acuminatis, nervo medio superne sulcato subtus prominente, venis numerosissimis confertis reticulatim divisis, versus marginem arcuatis; cymis paniculatis pyramidatis amplis laxe ramosis, ramis patentibus, (cum pedicellis fasciculatim dispositis), pilis glandulosis dense obsitis; calycis breviter tubulati sepalis ovato-lanceolatis purpureo-maculatis; corollæ 4^{mm} long. tubo subventricoso, petalis æstivatione contortis oblongis acutis sepalis duplo longioribus; filamentis versus basin tubi inter tuberculos parvos emergentibus petalis dimidio brevioribus;

antheris flavis demum basi cordato-bilobis, apice longe apiculatis, pollinis cellulis sphæricis; stylo corollam æquante vel superante.—Folia 20–25^{cm} long., 7–8^{cm} lat. Petiolus 2^{cm}. "Arbuscula gracilis 12–15 ped. fl. rubris albo-marginatis flavo-ocellatis."—Eastern slopes of Volcan Acatenango, Depart. Zacatepequez, alt. 7,000^{ft}, March, 1892, J. D. S., (ex Pl. cit. 2,485); Santa Rosa, alt. 4,000^{ft}, March, 1892, Heyde & Lux, (ex Pl. cit. 3,021).

Tabernæmontana arborea Rose.—A symmetrical tree, twenty-five feet high with trunk twelve feet long: leaves oblong to oblanceolate, three to eight inches long, abruptly acute or acuminate, tapering at base into a petiole (four to six lines long), shining above, paler beneath: flowers white, abundant in large compound corymbs: pedicels three to five lines long; bracts at base of flower none: calyx small; sepals oblong, obtuse one and one-half lines long: spreading scales four to five in the axil of each sepal: corolla tube slender, two to three lines long, narrower above, pubescent near the mouth; lobes oblong obtuse, five to six lines long: stamens inserted low in the tube, included: disk none; style short: follicles two, reflexed, compressed, oval, obtuse, two inches long, papillose-roughened.—The fruit in this species is much like *T. Donnell-Smithii*, but in habit, inflorescence, color and size of corolla, etc., the plant is very different. This species is not a typical *Tabernæmontana* but would belong to the genus *Peschiera* as the tribes were arranged by Miers. This latter genus, however, is not considered a valid one by Hemsley, nor by Durand. It differs from *Tabernæmontana*, as Miers defines it, in the shape of the corolla tube, the attachment of the stamens, the length of the style, absence of disk, papillose follicles and distinct ovaries—characters which it has in common with *Peschiera*, and which, if they be constant, ought to constitute a good genus. (J. N. Rose.)—Banks of the Rio Ocosito, Depart. Quezaltenango, alt. 250^{ft}, April, 1892, J. D. S., (ex Pl. cit. 2,766).

Tabernæmontana Donnell-Smithii Rose.—Large shrub 10 to 20 feet high, glabrous: leaves 3 to 8 inches long, 1 to 1½ inches broad, thin, oblong, tapering at base, abruptly long-acuminate, glabrous, entire, sessile or short-petioled: cymes with a few large flowers: bracts at base of flowers 3, broad and obtuse: calyx 5-parted; the two outer ones much shorter; the inner ones 8 lines long, 5 lines broad, obtuse, scales in

the axil of the sepals numerous: corolla yellow with broad obtuse lobes; tube 12 to 14 lines long a little swollen at the top: stamens inserted near the middle of the tube: disk prominent; style long; follicles 2, reflex, oblong and obtuse, $1\frac{1}{2}$ to 2 inches long by 1 to $1\frac{1}{2}$ inches broad; seeds numerous, oblong, 4 to 5 lines long.—Near *T. grandiflora*, but the follicles of this latter species are acuminate, the leaves evergreen, and the bracts and sepals different. Capt. Smith observes of this plant: "It is not exactly a tree in habit. It occurred everywhere I went from the coast up to the slopes of the volcanoes at an elevation of $5,000^{ft}$. The natives call it *cobal* (varnish gum)." *T. grandiflora*, as is known, was referred by Miers to *Stemmadenia*, but is retained by Mr. Hemsley in *Tabernæmontana*. The difference between these two genera is sometimes a little difficult to determine. My species has certainly the salver-form corolla of *Tabernæmontana*. (J. N. Rose.)—Under the following numbers of the series, collected by J. D. S., Depart. Escuintla, Escuintla, alt. $1,100^{ft}$, March 1890 (2,404), San Juan Mixtan, alt. 500^{ft}, April 1890 (2,405), Naranjo, alt. 300^{ft}, March 1892 (2,764), San José, sea-level, April 1892 (2,765); Depart. Amatitlan, Barranca de Eminencia, alt. $1,400^{ft}$, Feb. 1892 (2,762); Depart. Retalhuleu, San Felipe, alt. $2,000^{ft}$, April 1892 (2,763). Collected also by Dr. W. C. Shannon, U. S. A., Depart. Sololá, Primavera, alt. $1,400^{ft}$, Aug. 1891 (120), Santa Barbara, alt. 800^{ft}, Aug. 1891 (152); Depart. Suchitepequez, Las Animas, alt. 600^{ft}, Sept. 1891 (155).

Philibertia refracta.—Pubescent: stems branching: leaves ovate-lanceolate ($24–28 \times 10–12^{l}$), tapering to acute apex, base cordate, under surface except veins nitid, petioles a third as long: peduncles, equalling leaves; pedicels filiform, half as long, 18–22-fasciculate, hirsute, exterior bracts linear-lanceolate and foliaceous: calyx-segments narrow, acute, hairy: corolla rotate, reflexed, fuscous, smooth except ciliated margin, tube half as long as calyx (1^{l}), segments ovate-oblong ($2\frac{1}{2}^{l}$): exterior crown narrow; scales of the interior yellow, membranaceous, inflated-ovoid, more than half as long as corolla, a little exceeding gynostegium: ovaries glabrate, stigma conical and minutely bifid: follicles not seen.—Santiago, Depart. Zacatepequez, alt. $6,500^{ft}$, 1891, Rosalió Gómez, (ex Pl. cit. 787).

Asclepias Guatemalensis.—Stem stout, simple, about a yard high, pubescent: leaves subopposite, oval ($3–4 \times 1\frac{3}{4}–2^{in}$),

shortly acuminate, base cuneate, minutely scabrid above, flavescent beneath and with a pubescent conspicuous reticulation, lateral nerves approximate: peduncles 4–6, alternate at leafless summit of stem, linear-bracted; umbels many-flowered, pedicels exceeding flowers: calyx-segments linear-lanceolate (1^{l}), pilose on back, margins scarious: corolla-segments four times longer, oblong, spreading, yellow: anthers equalling staminal column ($1\frac{1}{4}^{l}$); coronal scales as long, white, cylindrical by involution of margins, rugulose, appendaged below sinuate apex with an as long incurved-subulate ligule: ovaries glabrous: follicles not seen.—The flowers of *A. ovata* Mart. et Gal., which may perhaps best be comparted with the above, differ by reflexed corolla, shorter pollinia and appendage of anther, conduplicate broad coronal scales ligulate from near base.—Santiago, alt. $6,500^{ft}$, 1891, Rosalió Gómez, (ex Pl. cit. 809).

Dictyanthus ceratopetala.—Hispid with spreading articulated hairs bulbous at base: leaves cordate-ovate ($2–3 \times 1–1\frac{3}{4}^{in}$), about a half longer than petioles, acutely acuminated, minutely scabrid above, punctulate beneath and nearly glabrate except ferruginous nerves, margin ciliate: pedicels 2–8-fasciculate, 4-bracteolate, tetragonal, short, with peduncle added not equalling petiole and usually not exceeding calyx, flowers in anthesis single and about an inch long: calyx-segments lanceolate (6^{l}): corolla glabrous, whole interior marked with elevated red-purple reticulations; tube semiglobose, a little exceeding calyx; limb divided nearly to tube; segments triangular, elongated ($5–6^{l}$), obtuse, margins revolute: fruit not seen. —Of the other species with reticulated corollas, *D. reticulatus* Benth. et Hook. and *D. parviflorus* Hemsl., the former is the more nearly related, differing as briefly described by peduncles nearly as long as petioles and 1-flowered, ovate calyx-segments, twice larger flowers.—Plain of Santa Rosa, alt. $3,000^{ft}$, Aug. 1892, Heyde & Lux, (ex Pl. cit. 3,999).

Fimbristemma stenosepala.—Leaves acuminated-oblong or oblong-lanceolate ($4–6 \times 1\frac{1}{2}–2\frac{1}{2}^{in}$), twice to thrice exceeding petioles: cymes subequalling leaves, pedicels distant and shorter than peduncle: calyx-segments subglabrate except margins, membranaceous, lanceolate, acute: corolla-segments broader and longer, apex apiculate and laterally erose: tube of corona short (2^{l}), pilose; the exterior border narrow, entire, fimbriate; the interior fringeless, appendaged ex-

ternally with distant quadrate lobes: follicles not seen.—Similar in habit, and nearly so in structure of crown, to *F. calycosa* described and figured in vol. XVI, 196, pl. XVI, of this journal; that species differs chiefly by less developed inflorescence, somewhat larger flowers, large oval scarious sepals, glabrous tube of crown with its interior border simply divided into contiguous deltoid bidentate lobes. Borders of Lake Ayarza, alt. 8,000^{ft}, Sept. 1892, Heyde & Lux, (ex. Pl. cit. 4,004).

Utricularia Verapazensis Morong.—A small plant with delicate 1–2-flowered scapes, 3 or 4^{cm} high. Bladder-bearing branches at the base, few and short, running under moss; bladders ½–1^{mm} long. Leaves radical, obovate, obtuse, 3–5-nerved, petiolate, about 5^{mm} long, persistent. Scape bearing a solitary, minute, subulate scale midway or lower. Pedicels capillary, 5–7^{mm} long, subtended by a deeply three-parted bract, the lobes linear-lanceolate, obtuse, half as long as the pedicel. Flowers 8^{mm} or more in diameter, apparently purple. Calyx deeply parted; the lobes large, rounded, entire, nearly equal. Upper lip slightly angled on the broad, rounded apex; lower lip much larger, three-lobed, the middle lobe emarginate; both lips slightly pubescent near and upon the margins. Spur upturned, acute, one-third longer than the lower lip, minutely glandular-pubescent. Capsule not seen.—Related to *Utricularia Endresii* H. G. Reichb. f. of Costa Rica, which grows in similar situations. Reichenbach calls his plant (Gard. Chron., 1874, 582) a "lentibulariaceous orchid." (T. Morong.)—Tree-trunks near San Pedro Carcha, Depart. Alta Verapaz, alt. 3,000^{ft}, Jan., 1887, Baron von Türckheim, (ex Pl. cit. 1,109).

TYNANTHUS GUATEMALENSIS, Botan. Gazette, XVIII, 6.

EXPLANATION OF PLATE XXII.—Fig. 1, flowering branch. Fig. 2, flower. Fig. 3, corolla laid open. Fig. 4, stamen. Fig. 5, pistil with interior of calyx. In figs. 2–5 the objects are variously enlarged.

Adenocalymna (?) Ocositense.—Glabrous: leaves conjugate, simply cirrhose; leaflets coriaceous, nitid, elliptical-oblong (5–7×1¾–2¾^{in}), abruptly acuminated and mucronulate, base rounded, both sides punctulate and sparsely sprinkled with patelliform glands, costal nerves 7–8 to a side; petioles about an inch long, petiolules a half shorter and glandular-incrassate at base and apex: peduncle from bracteose axils subeqalling petioles and the 2–4-fasciculate pedicels; lower

bracts (*foliola stipuloidea* of Miers) imbricating, the upper decussate and rhomboid-lanceolate with scarious tips: calyx sparingly glandular, campanulate (3^l high and broad), truncate, subdenticulate near margin: corolla puberulous, veiny, roseate and purplish, 3 inches long, tube narrowed gradually and not contracted at calyx, lobes more than half as long: stamens included: ovary ovoid ($1\frac{1}{4} \times \frac{3}{4}^l$), closely glandular-tuberculate, lips of stigma semicircular, ovules regularly 1-seriate within margin of dissepiment.—In the absence of capsules the generic characters have not been satisfactorily verified.—Climbing high with flowers that fade to white, banks of the Rio Ocosito, Depart. Quezaltenango, alt. 250^{ft}, April, 1892, J. D. S., (ex Pl. cit. 2,688).

Aphelandra Heydeana.—Fruticose: leaves membranaceous, nearly smooth, ovate to ovate-lanceolate or elliptical ($5–8 \times 2–3^{in}$), acuminate, more or less abruptly contracted and cuneately prolonged ($1\frac{1}{2}–2\frac{1}{2}^{in}$) into short petiole: rachis of solitary sessile spike short ($1–1\frac{1}{2}^{in}$), cano-pilose; bracts twice exceeding internodes, concave, nearly scarious, veiny, pubescent, obovate-oblong (6×3^l), prolonged into a half as long recurved convolute cusp, margins 1–2-spinulo-dentate: sepals subequalling bract, elongate-lanceolate, aristate, little exceeding the similar bractlets: corolla glandular-pubescent, crimson, $2\frac{1}{4}–2\frac{1}{2}^{in}$ long; posterior lip erect, oblong ($11 \times 3\frac{1}{2}^l$), quite entire; anterior lip as long, broadly (6l) obovate-oblong, lobes connecting lips lingulate (4^l): capsules not seen.—Well marked by third part of leaf mostly simulating an alate petiole, squarrose spike, sepaloid bractlets, entire upper lip of corolla.—Chupadero, Depart. Santa Rosa, alt. $5,000^{ft}$, Oct., 1892, Heyde & Lux, (ex Pl. cit. 4,037).

Explanation of Plate XXIII.—**Fig. 1, flowering branch. Fig. 2, corolla laid open. Figs. 3 and 4, bracts Figs. 5 and 6, pistil with bractlets and sepals. (Figs. 1 and 2 are natural size; the others are slightly enlarged.)**

PHYTOLACCA ICOSANDRA L., var. **octogyna.**—Leaves membranaceous, lanceolate-oblong, long-attenuate: bract equaling triquetrous pedicel ($3–4^l$): sepals oblong ($2\frac{1}{2} \times 1^l$), obtuse: stamens shorter, 14–18: styles 8: fruit depressed-globose, by abortion fewer-seeded. San Miguel Uspantán, alt. $7,000^{ft}$, April, 1892, Heyde & Lux, (ex Pl. cit. 3,031).

Tradescantia Guatemalensis C. B. Clarke (EUTRADESCANTIA).–Umbellis sessilibus bibracteatis, corolla intense cœrulea, antherarum loculis ovatis approximatis.—Stems procumbent,

rooting at nodes, pubescent on one side: sheathes 4–5^{l} long, margins villose; leaves ovate-acuminate or ovate-lanceolate ($1\frac{1}{2}$–$3 \times \frac{1}{2}$–1^{in}), acute, equal at rounded or narrowed base, subpetiolate, both surfaces glabrous or pilose: bracts foliaceous in form and size, unequal in the pair; pedicels of terminal umbels elongate (16–20^{l}), numerous, sparsely villose: sepals oblong (3×1^{l}), obtuse apex barbate: petals marked with undulate black lines: filaments pilose below, anther-cells adjacent and oblique, minute connective cuneate: capsule globose (2^{l}), puberulous, seeds to the cell two and subquadrate or one and longer, strongly rugose. (J. D. S.)—Santa Rosa, alt. 3,000^{ft}, April 1892, Heyde & Lux, (ex Pl. cit. 3,515); Volcan Pacaya, Depart. Amatitlan, alt. 9,000^{ft}, July 1892, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 3,665); Lake Ayarza, Sept. 1892, Heyde & Lux, (ex Pl. cit. 3,886).

Tinantia leiocalyx C. B. Clarke.—Sepalis extus omnino (aut fere) glabris, sine glandulis; pistillo 12-ovulato; cetera T. fugaci Scheidw. similis.—Erect (4^{ft}), branching, pubescence of stems scattered: leaves ovate ($2\frac{3}{4}$–$3\frac{1}{2} \times 1\frac{3}{4}$–$2^{in}$), acuminate, base rounded or sub-cordate, cuneately produced into petiole, pubescent above: peduncles and pedicels naked, smooth; bracts lanceolate (4^{l}), bractlets none: sepals large, oblong (6–7×2^{l}), in flower a half longer than pedicels: longer filaments spiral, 2 broadly scariose-alate and albo-arachnoid below middle, the third exbarbate, anthers elliptical (1^{l}); shorter filaments half as long, aureo-barbate at middle, anthers little smaller and circular. (J. D. S.)—Banks of the Rio Samalá, Depart. Retalhuleu, alt. 1,100^{ft}, Oct. 1891, Dr. W. C. Shannon, U. S. A., (ex Pl. cit. 695).

Baltimore, Md.

On the development of the caryopsis.

RODNEY H. TRUE.

WITH PLATES XXIV—XXVI.

Historical.

The structure of the fruit of the grasses seems to have received little attention prior to the beginning of the present century. During this period of increased interest in plant anatomy, some study was given to the structure of some of the commonest grains and even at this early date many observations were made that stood unquestioned until the last decade. Especially notable was the work done by Mirbel. He described for the first time the fruit of the Gramineæ and applied to it the name "*cerium*".[1] His definition was as follows: "A fruit in which, toward maturity, the ovary walls become united with the integuments of the seed. Richard[2], at a later date, gave the name of "*caryopsis*" to the same fruit defined in a similar way.

The researches of Schleiden[3] published in 1837 and in 1850 dealt with the fruit of the rye, *Secale cereale* L. In the earlier publication, the development of the grain was considered.

In 1870, Anton Nowaki[4] gave a condensed developmental history of the wheat grain and its envelopes.

In 1875, F. Kudelka published[5] the most complete account of the structure and the development of the common grains that had yet appeared. He described in great detail the development of the fruit of the rye from the time of the blooming of the flower to that of the ripeness of the seed. The general conclusions reached are substantially as follows: "Nie fehlende Schichten der Frucht- und Samenschale der Gramineen sind folgende: Die äussere Epidermis des Fruchtknotens, ein Theil des Parenchyms der Fruchtknotenwand, das innere Integument und die Epidermis des Knospenkerns. . . . In Folge von starkem Wasserverlust und Druck zur Zeit der Reife ist der innere Bau der Frucht- und Samenschale oft nicht deutlich erkennbar. Zusatz von Kali, wobei das betreffende Präparat aufquillt und dadurch mehr dem Stadium

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[1]The index numbers refer to numbered titles in the bibliography at the close of this paper.

der Milchreife ähnlich wird, ist durchaus erforderlich zur genaueren Betrachtung der einzelnen Schichten." The descriptions were accompanied by a number of plates. The most important literature on the subject was critically reviewed in the light of his results. To this review, I am indebted for the résumé of a number of early articles to which I have not had access.

W. Johannsen brought out in 1885[6] the results of his study of the development and constitution of the endosperm of the barley. Although not included in his main subject of study, he gave attention to the fruit envelopes. In minor details only did he depart from the results previously obtained.

In 1888, H. Jumelle published[7] the results of his investigations concerning the constitution of the caryopsis. As his conclusions differed very widely from the hitherto generally accepted view, I quote them. "A aucun moment, pendant la maturation du grain des Graminées, il n'y a soudre entre les téguments de la graine et le péricarpe. Le péricarpe se résorbe en partié; les téguments de la graine disparaissent complétement. Le fruit des Graminées ne mérite pas un nom spécial; c'est un akène renferment une graine sans tégument." Detailed observations on the wheat were given in the article, but other cereals were studied and all contributed to the results quoted.

In the same year, the same conclusions were announced in an article of wider scope.[8]

A. Zoebl made an investigation in 1889[9] of the structure of the envelopes of the seed of the barley, *Hordeum distichum* L. After describing in detail the structure of the outer envelopes, the seed coats in the mature specimen were described in substance as consisting of two layers of cells united without spaces. The outer is much heavier than the inner which is often described as the "hyaline layer."

The latest reference to the subject that has come to my notice is found in Van Tieghem's Traité de Botanique, where I find this statement: "Chez les Graminées, le tégument externe de ovule est resorbé comme le tégument interne, et la membrane des sac embryonnaire vient s'accoler intimement contre le face interne des pistil. La graine y est depourvue du tégument."[10]

Introductory.

The question involved in these discussions is one of some importance. The existence of the *caryopsis* as a type of fruit distinct from the *achene* has not been challenged, so far as I have been able to learn, until 1888 by Jumelle in the above cited articles. The adoption of his view and the incorporation of it into so important a treatise as that of Van Tieghem is likely to lead to confusion. To determine whether the earlier and accepted view or that of Jumelle is correct has been the object of this investigation.

To this end a careful study has been made of the history of every part concerned from the time of the fertilization of the ovule to that of the complete ripening of the seed in the corn *(Zea Mays* L.), wheat *(Triticum vulgare* Vill.), and the oat *(Avena sativa* L.). As the developmental history of the fruit of the corn has received less attention heretofore than that of the other common cereals, I have described it with some detail. The wheat and oat receive briefer mention.

The grains used were collected from fields near Baraboo, Wis., during the summer and fall of 1890. The material used was gathered at suitable stages of development from plants of typical growth, and while fresh was immersed for from twelve to twenty-four hours, according to its bulk, in a solution of chrom-acetic acid. The following proportions by volume were used: saturated solution of chromic acid, 3 parts; acetic acid, 7 parts; rain water, 990 parts. To enable more rapid and complete penetration of the tissues of the corn to take place, the young axes were cut into small pieces. From the acid the material was transferred to weak alcohol after the removal of the surplus acid by thorough and repeated washing in rain water. After gradual hardening in alcohol of increasing concentration it was placed in commercial alcohol for permanent preservation. The younger stages were imbedded in paraffin and serial sections were cut with the microtome. Older grains were cut free hand. The use of potassic hydrate was found advantageous in studying much compressed tissues to swell them.

Zea Mays L.

At the time of the maturation of the egg apparatus, the ovary is unsymmetrical in form, being bent from the perpendicular in such a manner as to cause the long style, or "silk"

of popular phrase, to point in the direction of the end of the spongy, club-shaped axis, the cob, fig. 1. At this stage, the ovary is about 2.5^{mm} long and at the point of greatest width, the base, has a diameter of about 3^{mm}. It is raised on a thick pedicel about 2.5^{mm} in height. Attached to the sides of this pedicel and wrapped up closely about the ovary so as to nearly cover it, are the glumes and palets in the form of more or less fleshy scales. These parts occupy the characteristic positions in the flower. The two broad, fleshy outer glumes with fimbriated edges cover the more delicate flowering glume on one side and the third empty glume and the two palets on the other. The single ovule is attached by more than a third of its circumference directly to the floor of the ovary. The funicle is, therefore, not present. The ovule is very large and nearly fills the cavity of the ovary. Its form, like that of the ovary, is unsymmetric being so strongly curved as to be decidedly campylotropous. At this stage, the integuments of the ovule are fully developed, fig. 5. The micropyle is situated on the side adjacent to the flowering glume just above the point of attachment. The outer integument is incomplete, failing to cover an area extending from the micropyle to the base of the style, in length, and in width equal to about one-half the diameter of the ovule. It is present between the micropyle and the base of the ovule in the form of a short tongue-shaped projection. The inner integument forms a complete covering except at the micropyle.

The wall of the ovary at this stage attains a greater thickness than at any other time in its history, its average thickness being about 0.4^{mm}. It is bounded externally by an epidermis composed of cells containing large nuclei. The parenchyma forming the bulk of the wall consists of rounded and short-prismatic cells. In the outer third of the wall, the cells are much smaller and more elongated than those of the deeper parts. Hence intercellular spaces while very rare in the former region, are abundant and large in the latter. The cells of the inner two-thirds are large, rounded and necessarily more loosely arranged. The dividing line between these regions at this stage is not sharply defined, but later becomes very evident. Adjacent to the inner epidermis are two or more layers of small cells which are elongated in a direction transverse to the longitudinal axis of the ovule. The inner epidermis consists of small, nearly cubical cells.

Over the greater part of its surface, the outer integument is in contact with the ovary wall. Figs. 3, 4.

In a considerable number of specimens, a pit was observed a short distance from the base of the style, on the posterior side. In some cases the depth of the pit at this stage was equal to one-half the thickness of the ovary wall. The edges were rounded and complete, showing that this space was due to a failure of the parts to unite completely. In younger specimens in which the embryo-sac had not yet developed, this pit was generally to be found. In many of these cases, the pit extended entirely through the ovary wall exposing the already developed outer integument. It seems that at this stage of development, the edges of the carpel have not yet completely united. Fig. 2.

The outer integument is, in the main, four layers of cells in thickness. Toward the top of the ovule it is reduced to two layers, except at the base of the style where it is thickened into a broadly wedge shaped mass which projects for a short distance into the base of the style, fig. 7. The short portion projecting over the anterior face is terminated by a single layer of wedge shaped cells. This integument is for the greater part in close contact with the ovary wall on the outside and with the inner integument on the inner side, but anterior to the base of the style there is often a considerable space between it and the ovary wall. As this region is traversed by the descending pollen tube, it is possible that it may aid in determining its course. The cells constituting this integument are generally short-prismatic, rather regular and have very thin walls, figs. 3, 4. The short wedge-shaped portion found below the micropyle is in close contact with a similar part of the inner integument, but is removed from the ovary wall by a considerable space, fig. 8.

The inner integument varies in thickness from four layers of cells near the base of the ovule to two toward its apex. The cells as in the outer integument are short-prismatic in form but are considerably larger. The inner integument is closely in contact with the nucellus. At no points are the integuments strictly united with any of the adjacent organs save only at the points of their origin. At intervals, narrow spaces may be seen between adjoining structures. The function ascribed to the integuments seems to be that of protection to the parts enclosed. Holzner[11] regards it as probable that they

serve in some degree to give direction to the pollen tube. Hackel[12] says that the outer integument of the ovule of the Gram neæ "has very delicate walls, and forms a conductive tissue for the pollen tube upon the anterior side." Figs. 3, 4.

The nucellus consists of large isodiametric cells with small nuclei and scant contents. It is bounded by an epidermis with strongly cutinized outer walls. This cuticle is conspicuous in all stages of growth by reason of its great affinity for staining fluids. Toward the base of the nucellus, in its anterior part is found the embryo sac. In this grain it is very large, being readily sectioned even by free-hand methods.

For a very short time after fertilization no general change is noticeable in the ovule outside of the embryo sac. As the embryo and endosperm increase in size, they begin to exert a pressure on the adjacent tissue of the nucellus. Signs of yielding begin to be manifest here soon. Even earlier, in fact shortly after fertilization, the outer integument begins to show signs of weakening at the apex of the ovule near the base of the style. Soon after, the walls of the cells toward the outer surface of the young pericarp begin to thicken, especially those adjacent to the epidermis. The disintegration of the outer integument proceeds now more rapidly and it becomes increasingly difficult to detect the cell walls owing to their partial absorption and collapse. The first point of complete disappearance is at the apex of the ovule.

Previous to the collapse of the outer integument, the inner integument shows little change. Shortly, however, a slight tendency to weaken is seen, especially in the external layer of cells. In many the partitions become wrinkled. That a considerable pressure is exerted from within, is shown by the close contact of the inner integument with the ovary wall in places where the outer integument has disappeared. The nucellus is forced to undergo increased compacting to make room for the growing embryo and endosperm.

At a somewhat later stage, profound changes in the pericarp begin to manifest themselves. Toward the top of the ovule, the large-celled, thin-walled parenchyma of the middle and inner parts of the ovary wall begins to weaken and a crumpling or collapse, together with a compacting, of the cell walls becomes conspicuous. The outer boundary of the region in which this change takes place, is rather regular and is very

definite. It extends nearly parallel to the inner epidermis at a distance from it of about one-third the thickness of the ovary wall. Fig. 9.

As a result of resorption, the rounded cells within this region are freed from each other leaving the original tissue represented by a stratum of detached cells. Absorption may go further leaving but indistinct remnants of some of the cells themselves.

This disintegration affects in less degree the inner epidermis and the adjacent elongated cells. The combined influences of partial disintegration and of pressure transmitted from the growing embryo separate the epidermal cells laterally. As a result, instead of forming a sheet, the epidermis has come to consist of ribbons of cells attached by their ends alternating with narrow spaces of approximately equal width. In short, the deeper tissues of the ovary wall in the region of the apex of the ovule have undergone a more or less complete disintegration. The walls of the outer epidermal cells and a few layers of cells beneath it, show some thickening, and in the walls of the latter cells, pits are noticeable.

At this stage the outer integument has entirely disappeared, fig. 6. The cell walls of the inner integument begin to weaken and collapse, but the layer can be easily seen in cross sections. Of the nucellus only two or three layers of cells remain except at the base of the ovule, where a considerably thicker and much compacted body of cells is found. The greater part of the missing tissue has been absorbed, but evidence of compression is found in the form of collapsed cells adjacent to the endosperm and embryo.

The cells of the endosperm are very thin walled and contain large nuclei and granular protoplasm. The peripheral cells are smaller and richer in protoplasm than those of the interior parts, the latter containing large vacuoles. The cells of the embryo are smaller than those of the endosperm and are in an active state. The use of proper stains brings out well the details of nuclear division in these cells. Even at this early stage the glandular layer is distinctly differentiated as small epidermal-like superficial cells.

As development continues the modifications indicated in earlier stages become more and more pronounced. The thickening of the walls of the outer epidermis of the ovary

and the underlying parenchyma continues; the disintegration in the inner parts extends toward the base of the ovule on all sides and becomes more nearly complete. The strips of cells representing the inner epidermis become more widely sundered.

For the most part the inner integument suffers compression of its elements and can be distinguished with difficulty. Of the nucellus nearly all the cells suffer absorption. An exceptional region is seen at the base of the ovule. Here a considerable quantity of the compressed tissue remains, persisting, in fact, even in the mature fruit. The epidermis of the nucellus with the strongly cutinized outer surface resists absorption, and although suffering compression may be readily recognized by the deeply stained cuticle.

The endosperm cells begin to assume their characteristic appearance. The aleurone layer contains abundant protein grains and the thickening of its cell walls is noticeable. The interior cells contain a few starch grains of the usual size and many smaller granules. The cell nuclei are still present.

From this stage to that of ripeness, the change is quickly made. In the mature grain the walls of the outer epidermis of the pericarp and the underlying parenchyma are so strongly thickened that the lumina are almost reduced to lines, fig. 10. The pitting of the walls is rendered conspicuous by treatment with a 5 per cent. solution of potassic hydrate. A distinct cuticle bounds the epidermis, but the underlying walls are rarely cuticularized.

Between the outer intact part of the ovary wall and the inner disintegrated region, lies a narrow line of compressed cells and débris. This compression seems to be the result of the outward pressure exerted by the growing embryo and endosperm. The resorption of the inner parts progresses until few or no detached cells or walls or remnants remain. There is thus formed an irregular cavity bounded externally by the jagged line of compacted remains and bounded internally by the sundered parts of the inner epidermis and the inner integument. As the growth within continues, this jagged gap is lessened in width until in the mature grain the limits come to lie adjacent to each other, fig. 10. In places, the inner epidermal cells are in contact with the line of compacted cells. In the mature grain, the lumina of these compacted cells appear to be mere striations and the limits of the individual cells are visible only upon treatment with potassic hydrate.

In places, small portions of the inner epidermis seem to have been resorbed, but generally its separated elements persist and become united to the adjacent inner integument. This union is distinctly seen under high magnification after treatment in warm potassic hydrate. This soldering together of ovary wall and integument takes place late in the history of the fruit, probably after the "green-ripeness" of Kudelka. Occasionally cells of the inner epidermis are found soldered to the compacted cells of the ovary wall indicating that the union took place after the two tissues had been brought near together. As a result of compression and resorption, the ovary wall having an average thickness of about 0.4^{mm} at the time of flowering has been reduced to a thickness of about 0.145^{mm} in the ripe fruit.

In a ripe grain, the inner integument is visible only after treatment with potassic hydrate, and then in radial and cross sections of the grain as a line only. In tangential sections only is its cellular structure distinguishable. In close contact with it is the epidermis of the nucellus. This is likewise strongly compressed but the lumina of its cells can be detected after treatment with potassic hydrate. In stained sections the cuticle is conspicuous. At the base of the seed may be seen a considerable mass of the nucellus tissue. This is distinctly visible to the unaided eye as a small area of whitish color near the point of attachment of the seed. The aleurone layer has very strongly thickened walls at maturity which are found to be beautifully stratified after treatment with potassium hydroxide. At ripeness, the cells of this layer are closely packed with their characteristic contents. The interior cells of the endosperm have thinner walls and are closely packed with food materials consisting in the main of starch.

Triticum vulgare Vill.

As the developmental history of the wheat and of the rye has been described with a greater degree of completeness than the corn, I shall here give very briefly the results reached in the study of the wheat.

At the time of the maturation of the ovule, the ovary is broadly conical in outline with the apex directed downward. The posterior side is traversed for nearly its entire length by

a groove which marks the position of the fibro-vascular bundle and also shows in a general way the position and extent of the attachment of the ovule to the ovary. The broad upper part of the ovary is thickly beset with rather coarse hair-like trichomes. The ovule is strongly campylotropous, being attached along its side to the ovary, carrying the micropyle at the lower end.

The ovary wall is of irregular thickness, in general becoming thicker toward the top of the ovary. It consists of an outer epidermis, many layers of rounded parenchyma generally looser in the deeper parts of the wall than near the outer epidermis, a single layer of cubical chlorophyll-bearing cells and a delicate inner epidermis. Near the furrow, the chlorophyll-bearing cells may frequently form a double row.

The integuments arise along the posterior side of the ovule and are complete except at the micropyle. They each consist very uniformly of two layers of cells with delicate walls. The enclosed nucellus is of a somewhat conical outline and is composed of the characteristic thin walled parenchyma tissue bounded by a distinct epidermis. The integuments are in contact with the ovary wall, with the nucellus and with each other, but at this stage are not structurally connected.

After fertilization the first marked change is the weakening of the elements of the outer integument. They become gradually more and more indistinct until the integument disappears entirely. In the ovary wall, the first change is seen in the parenchyma just external to the chlorophyll-bearing layer. A broad zone of this tissue is gradually absorbed leaving the outer epidermis and from two to four layers of the underlying parenchyma still intact. The inner epidermis also gradually disappears either completely or in great part. The nucellus as a matter of course undergoes very early changes. The cells about the young embryo and endosperm are compressed and resorbed to make room. These changes in the various parts proceed with considerable rapidity.

As the fruit develops, the processes of modification above mentioned continue. The chlorophyll cells elongate tangentially and assume a somewhat canoe-shaped outline when seen in cross sections of the grain. The cells lose their chlorophyll and the walls become strongly thickened and conspicuously pitted. Of the inner integument, both layers

of cells persist. As development goes on, the outer layer becomes inconspicuous on account of the obliteration of the cell lumina and the almost hyaline appearance of the walls. The inner layer suffers less compression usually on account of the thicker walls, but often treatment with potassic hydrate is necessary to bring out the elements. With the exception of the region near the fibro-vascular bundle and the epidermis, the nucellus is eventually all resorbed. The epidermis persists in a compressed condition.

At maturity, the ovary wall outside of the chlorophyll layer consists of two or three rows of cells with strongly thickened walls and narrowed lumina, fig. 13. The space formerly occupied by the absorbed portion of the wall has been filled by the outward movement of the inner growing parts thus bringing the chlorophyll layer in contact with the remaining cells of the ovary wall. The remaining cells of the inner epidermis, when present, and, in their absence, the former chlorophyll-bearing cells, are soldered to the hyaline outer layer of the inner integument and sometimes also exteriorly to the adjacent cells of the wall. Of the existence of this union, I think there can be no doubt. The inner integument, said by Jumelle to be absent, was present in every specimen I have examined and is plainly distinguishable under moderate magnification in specimens that have been treated with potassic hydrate. The hyaline outer layer is not easily demonstrated, but the thicker walled inner layer is readily seen, fig. 12.

In "red" wheats, particularly, this is true, since in the cell cavities of this layer is deposited a quantity of rusty red coloring material that catches the eye at once. The difference in color between the so-called red and white wheats depends on the presence or absence of this coloring matter in the inner integument. As far as I have been able to ascertain, this layer of cells is always present in the white wheats but is less conspicuous than in the red.

Thinking that possibly a difference between American and European varieties might account for the different results I have reached from Jumelle, I obtained through the kindness of the Department of Agriculture a number of specimens of European wheats which I examined with this possibility in mind. These however exhibited the same structures as

already described. I am therefore compelled to dissent from Jumelle's conclusions, which Van Tieghem has adopted in his voluminous treatise.

The epidermis of the nucellus is seen in mature specimens after treatment with potassic hydrate, but with well nigh obliterated lumina, fig. 13.

Avena sativa L.

At the time of flowering, the ovary of the oat differs in appearance from that of the wheat chiefly in the more complete covering of hairs. As development proceeds, however, other and more fundamental differences appear. Owing to the assumption by the bracts of the protective function, the pericarp is thinner and more delicate than in the grains described above. Resorption of the ovary wall goes further than in the corn and wheat, fig. 11. The chlorophyll cells as well as the inner epidermis and a greater part of the ovary wall disappear. As a result, in the ripe fruit, the pericarp comes to consist of the outer epidermis and a layer or two of adjacent interior cells only. As in the wheat, the outer integument disappears and the inner persists. It is very delicate, however, and in the ripe fruit reveals its structure only upon treatment with potassic hydrate. In fig. 11 the layer adjacent to the endosperm is the epidermis of the nucellus. The inner integument, *i*, includes only the layer external to this.

The soldering of adjacent elements of integument and pericarp takes place less freely than in the corn and wheat. Owing to the great absorption of the tissue of the ovary wall, the remaining part comes to approach somewhat the condition of the loose utricular covering. As growth from inside progresses, the integument approaches this loose remnant, and in places eventually comes in contact, but never so closely as in the wheat. As a result, the pericarp is soldered to the integument at fewer points and is removed with less difficulty. The epidermis of the nucellus persists, but is plainly distinguishable only after treatment with potassic hydrate.

Some other fruits of the Gramineæ were examined, but less carefully than those described above. The results obtained were in the nature of corroboration of the doctrine that the pericarp and integument unite in the fruit of the grasses.

As further opportunity shall permit, it is my intention to examine at different stages of development the fruits of related plants to ascertain, if possible, how widely this history is the history of other forms.

Summary.

I summarize my results and conclusions as follows:

I.—In the corn, wheat and oat, at the time of fertilization, the single ovule is furnished with two integuments, which are more or less complete. As development proceeds (1) the outer integument soon disappears; (2) the inner cells of the ovary wall are absorbed in varying proportions; (3) the tissue of the nucellus is absorbed, with local exceptions.

II.—At maturity, these remain as seed coverings: (1) the external portion of the ovary wall, in varying proportion, forming the pericarp; (2) the inner integument persisting in a state of compression. The epidermis of the nucellus also persists, though much compressed.

III.—Late in the development of the fruit, the remaining (inner) integument becomes soldered to the adjacent inner cells of the pericarp forming the fruit correctly described by Mirbel under the name of "cerium," and rechristened by Richard the "caryopsis."

This investigation was pursued in the botanical laboratory of the University of Wisconsin, under the direction of Prof. Charles R. Barnes. For his kind suggestions and help I wish to express my sincere gratitude.

Madison, Wis.

Bibliography.

While the literature of the development of the grains and, in an incidental and general way of their coverings, is somewhat extensive, few papers give to the coats a detailed study. I have here listed only those writings which touch most dlrectly and definitely upon the subject in hand and such, therefore, as would be most useful for general reference.

1. Mirbel: Ann. Mus. Nat. XIII.
2. Richard, L.: Analyse des embryons et endorhizes.
3. Schleiden: Ueber die Bildung des Eichens und Entstehung des Embryo bei Phanerogamen. Nova Acta Leopoldinæ Carolinæ Academiæ. 1837.

4. Nowaki, Anton: Untersuchungen über das Reifen des Getreides, etc. Verlag der Buchhandlung des Waisenhauses. Halle. 1870.

5. Kudelka, F.: Ueber die Entwickelung und den Bau der Frucht- und Samenschale unserer Cerealen. Landw. Jahrbücher. 1875, p. 460. Published also at Leipzig in 1875 underthe same title as an Inaugural-Dissertation.

6. Johannsen, W.: Om frohviden og dens udvekling hos byg. 1885.

7. Jumelle, Henri: Note sur la constitution du fruit des Graminées. Compt. Rend. CVII, 285.—Same abstracted in Just's Bot. Jahresber. 1888, 788.

8. Jumelle, Henri: Sur les graines à deux téguments. Bull. de la Soc. Bot. de France, 1888, p. 35.—Abstract in Just's Bot. Jahresber. 1888, p. 748.

9. Zoebl, A.: Der anatomische Bau der Fruchtschale der Gerste, *Hordeum distichum* L. Verh. d. naturf. Vereins in Brünn, XXVII (1889). 26.—Abstract in Bot. Centralb. 1890, p. 179.

10. Van Tieghem, P.: Traité de Botanique, I. 924. Paris, 1891.

11. Holzner: Bot. Centralb. XII (1882). 107.

12. Hackel, E.: True Grasses, translated by Scribner and Southworth. Henry Holt & Co., N. Y. 1890.

Explanation of Plates XXIV–XXVI.—Abbreviations used: *a*, outer integument of ovul.e—*b*, pedicel bearing the flower (Fig. 1); fibro-vascular bundle (Fig. 5.).—*c*, area of disintegration —*d*, inner epidermis of ovary wall.— *e'*, *e''*, *e'''*, empty glumes in order.—*f*, flowering glume.—*g*, line of compacting of cells in ovary wall.—*i*, inner integument of ovule.—*m*, micropyle.—*n*, nucellus.—*o*, ovule.—*s*, base of style.—*t*, endosperm.—*w*, wall of ovary.—*x*, chlorophyll bearing layer of ovary wall.—*y*, embryo sac.—*z*, pit in ovary wall near base of style in young ovules.

Plate XXIV.—Fig. 1. Longitudinal antero-posterior median section through the ovary of the corn at the time of the maturation of the ovule. × 30.

Fig. 2. Same view of the young ovary prior to the formation of the embryo sac showing the pit near the base of the style. × 45.

Fig. 3. Transverse section through the median region of the ovary wall and integuments of the corn at the time of blooming. × 325.

Fig. 4. Longitudinal view of the same parts at the same stage. × 325.

Plate XXV.—Fig. 5. View of the ovary and contents of the corn seen in median longitudinal antero-posterior section. × 45.

Fig. 6. Longitudinal section of the inner coverings of the ovule of the corn. Disintegration appears in the ovary wall, the outer integument has disappeared and the nucellus suffers compression. × 325.

Fig. 7. Antero-posterior longitudinal section of the integuments in the ovule of the corn showing the wedge-shaped thickening of the outer integument projecting into the base of the style. × 325.

Fig. 8. View of the integuments at the micropyle as seen in the longitudinal median section of the corn. × 325.

Fig. 9. Transverse section of coats, etc., in the middle region of the ovule of the corn. The line of compacting in the ovary wall has formed, the innermost cells are freed, the inner integument is compressed, the epidermis of the nucellus remains. × 325.

PLATE XXVI.—Fig. 10. Transverse section of the coats of the corn grain at maturity after treatment with cold potassic hydrate. × 400.

Fig. 11. Transverse section through the coats of the mature oat grain showing the union of the remaining cells of the ovary wall with the inner integument. The layer to the left of *i* is the inner integument; to the right, the epidermis of the nucellus × 465.

Fig. 12. Transverse section of the inner coverings of the mature wheat grain, showing union of the chlorophyll cells of the ovary wall with the inner integument after treatment with KOH. × 735.

Fig. 13. Transverse section of the coverings of the mature wheat grain. × 465.

Contribution to the biology of the organism causing leguminous tubercles.

GEO. F. ATKINSON.

WITH PLATES XII–XV.

[Continued from p. 166.]

Historical resume.

Early period of investigations.

The tubercles were at first supposed to be normal parts of the plants on which they were found. According to Vuillemin[6], De Léchamp[7] named the genus *Ornithopus* from the character of the tubercles and De Candolle[8] uses the form of the tubercles as one of the characters of a variety of *Ornithopus perpusillus.*

Bivona[9] took them to be fungi of the genus *Sclerotium* and distinguished two types, the simple ones as *S. lotorum* and the lobed ones as *S. medicaginum.* Persoon's *Sclerotium rhizogonum*[10] was also founded upon certain of these tubercles. Fries[11] rejects Persoon's *S. rhizogonum* referring the forms on

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[6]Les tubercles radicaux des Légumineuses. Ann. d. Sci. Agronom. franç. et etrang. 1888. p. 96.

[7]Histoire générale des plantes. 1615.

[8]Prodromus Syst. Nat. Reg. Veg. II (1825). 312.

[9]Pugill. plant. rar., Siculæ, IV. 26.

[10]Traité sur les champignons comestibles, Paris. 1818.

[11]Systema Mycologicæ, II. 250.

which it was based to growths from the roots of *Vicia*, etc. Fries however retains Bivona's two species *S. lotorum* and *S. medicaginum* and it was reserved for Tulasne[12] to cast them out of the category of fungi. To A. P. DeCandolle[13] they resembled small fungi like *Sclerotium* but he regarded them as diseased outgrowths and Wigand[14] recently has looked upon them as pathological forms.

Jessen[15] doubts their parasitic origin, and Clos[16] believed them normal structures with a physiological role and called them lenticels.

Others saw in them the products of animal parasitism, Malpighi[17] giving to insects the credit of their origin while Cornu[18] preferred to charge them to the account of *Anguillulidæ*. Later he withdrew the charge and treated them as root branches.[19]

Those who have argued that the tubercles were normal organs of the Leguminosæ hold very diverse views as to their function in the plant economy. Gasparini[20] describes them as swollen lateral roots and with Kolaczek[21] thought they were organs for absorbing food. DeVries[22] and Wittmack[23] interpreted them as lateral roots with dwarfed growth, while Treviranus[24] judged they were imperfect buds which in case

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[12]Fungi Hypogaei. 1851.

[13]Mémoire sur les Légumineuses. 1825.

[14]Bakterien innerhalb der geschlossenen gewebes der knollenartigen Anschwellungen der Papilionaceen Wurzel. Bot. heft. Forsch. aus dem Bot. Gart. Z. Marburg, 1887, p. 88, cited by Pichi, Atti della Società Toscani di scienze naturali, 1888.

[15]Sitzungsbericht d. Bot. Verein d. Prov. Brandenburg, 1878. p. 54.

[16]Ebauche de la rhizotaxie, 1848; Du collet dans les plantes et de la nature de quelques tubercles. Ann. d. Sci. Nat. Bot. III. XIII. 1849.

[17]Anatome Plantarum pars sec. de Gallis. Opera I. 1687, cited by Vuillemin, l. c. See also Sorauer, Pflanzenkrankheiten. I. 744; Frank, Krankheiten der Pflanzen.

[18]Commission du Phylloxéra. 1876.

[19]Etudes sur le Phylloxera vastatrix. Memoires de l' Académie des sciences. XXVI. 1878.

[20]Osservazioni sulla struttura dei spongiolari di alcune piante leguminose, Lette all. Ac. di Napoli, 1851; cited by Tschirch, Ber. d. deutsch. bot. Gesells. v (1887). 58.

[21]Lehrbuch der Botanik, 1856. p. 374.

[22]Wachstumsgeschichte des roten Klees. Landw. Jahrb. von Theil 6, I, 1877; Verhandlung d. Bot. Vereins d. Prov. Brandenburg. 1878. p. 54-55.

[23]Verhandlung d. Bot. Vereins d. Prov. Brandenburg. 1874. p. 54.

[24]Ueber die Neigung der Hülsengewächse zu unterirdischer Knollenbildung. Bot. Zeit. 1853, p. 393. See Vuillemin.

the plants did not fruit could themselves develop into perfect plants. According to Nobbe,[25] Lachman,[26] Mattirolo e Buscalioni[27] they were places for the storage of reserve food materials.

These notions were probably empirical and derived more from superficial examination than from any serious attempt at an anatomical study of their structure and contents.

Middle period of investigations.

The period of serious investigation into their structure and etiology begins with Woronin's[28] contribution in 1866. He described the tubercles as being composed mainly of a parenchymatous tissue which is separated into an inner central mass and an outer layer, the two portions being separated by a layer of fibro-vascular tissue which arises from corresponding tissue in the central cylinder of the root. The inner parenchyma he described as possessing turbid contents while the outer was clear. The growing point or meristem of the tubercle lies in the distal portion of the inner parenchyma, the proximal portion being occupied by bacteria-like bodies or vibrios which filled the plasmic substance. These he considered to be the cause of the tubercles.

The next important contribution was by Eriksson[29] who distinguished what he supposed were two organisms in the tubercles. One he verified as the vibrio-like bodies discovered by Woronin which occupy the proximal portion of the central parenchymatous tissue. In the distal portion of the central parenchymatous tissue he discovered what he took to be fungus strands lying in a radial position, branching into finer threads as they approached the center. He described

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[25] Vegetationsversuche in Boden mit lokalisirten Nährstoffen. Landwirtschaftliche Versuchstationen, 1868, p. 98.

[26] Ueber Knollchen der Leguminosen. Landw. Mittheil. Zeitschr. d. k. Lehranstalt und Versuchstationen, Poppelsdorf, 1856, p. 37. Cited by Tschirch, l. c.

[27] Si Contengono bacteri nei tubercoli radicati delle Leguminose? Malpighia 1, *21*, 464, cited by Pichi, l. c.

[28] Ueber die bei der Schwarzerle und der gewœhnlichen Garten-Lupine auftretenden Wurzelanschwellungen, Mem. d. l' Acad. Imp. d. Sciences, VII. x. (1866) 2.

[29] Studier öfver Leguminosernasrotknölar, Lund, 1874; Bot. Zeitung, 1874, p. 381. Cited by Vuillemin, l. c. and others

also the characteristic enlargements of these structures where they pass through the cell walls. He believed these fungus hyphæ to be the real cause of the tubercles.

DeVries[30] observed the hyphæ described by Eriksson but did not believe they stood in causal relation to the tubercles.

Schindler[31] also detected the hyphæ but claimed they enter after the tubercles begin to degenerate, while Cornu[32] and Mattei[33] declare there exists no mycelium in the tissues.

Kny[34] recognizes the presence of strands but denies the presence of a membrane. He believed they were strands of a plasmodium similar to Woronin's *Plasmodiophora brassicæ*[35] and about this time Woronin[36] retreats from his former position that the tubercles were caused by bacteria or vibrio-like bodies, and believes them to be due to a plasmodium, being influenced probably by his studies upon the club-foot of cabbage.[37] Prillieux[38] largely corroborated the studies of Eriksson, especially in regard to the structure of the tubercles and their parasitic origin, but believed them to be caused by a plasmodium, related to Woronin's *Plasmodiophora brassicæ*, which excretes a viscid substance.[39]

In 1879[40] appeared B. Frank's first important paper on the subject. He found both the hyphæ and the bacteria-like bodies. He believed the latter sprouted off from the former. In an earlier publication[41] he thought the fungus to be closely allied

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[30] Wachstumsgeschihcte des roten Klees. Landw. Jahrb. 1877.

[31] Ueber die biologische Bedeutung der Wurzelknœllchen bei den Papilionaceen. Jour. f. Landw. XXXIII, (1885), 325–336. Ueber die Bedeutung der sog. Wurzelknœllchen bei den Papilionaceen. Œsterreich. landw. Wochenblatt XI (1885), n. 34, cited by Tschirch, l. c. Zur Kenntniss der Wurzelknœlchen der Papilionaceen. Bot. Centralb. XVIII (1884), 86.

[32] Mem. d. l' Acad. d. Sciences, XXVI (1878).

[33] Ancora sull. origine della Vicia faba. Bologna, 1887, cited by Vuillemin. l. c.

[34] Verhandlung. d. Bot. Vereins der Prov. Brandenburg, 1877. Ueber die Wurzelanschwellungen der Leguminosen und ihre Erzeugung durch Einfluss von Parasiten. Ibid. 1878.

[35] Pringsheim's Jahrb. f. wiss. Bot. XI, 548.

[36] Ibid., p. 371.

[37] Ibid., p. 548.

[38] Sur la nature et sur la cause de la formation des tubercles qui naissent sur les racines des Légumineuses. Bull. Soc. Bot. d. France, 1879, p. 98.

[39] Comptes Rendus d. sc. Paris, CXI, 926.

[40] Ueber die Parasiten in den Wurzelanschwellungen der Papilionaceen. Bot. Zeitung, XXXVII (1879), n. 24, 25.

[41] Leunis: Synopsis: Kryptogamen, p. 1,944.

to the genus Protomyces of De Bary,[42] but now he transfers it to the genus *Schinzia* founded by Nægeli[43] on a fungus which causes galls on the roots of *Cyperus*, and calls it *Schinzia leguminosarum*, thus considering it to be closely related to the fungus in galls on the roots of Alnus first described by Woronin.[44] It is quite important in view of Frank's change of opinion at a subsequent date to note that an examination of the illustrations and descriptions which accompany this paper leaves no doubt that at that time he considered the bacteria-like bodies to be budded off from the hyphæ though he did not actually see the budding take place. This paper of Frank's brought out a rejoinder from Kny[45] who states that the bacteria-like bodies are the spores of the plasmodium.

The general effect of these investigations was to give a feeling of confidence in the view that the etiology of the tubercles was primarily due to the irritating or stimulating influence of some organism in the soil, though there was great diversity of opinion as to the character of the organism.

This feeling of confidence, however was soon shaken by the appearance in 1885 of a paper by Brunchorst.[46] Brunchorst claims that the tubercles are not caused by any organism. He affirms the older views that they are normal structures. To the vibrio-like bodies he ascribes an entirely new role. He believes them to be differentiated portions of the plasmic protein contents of the cells. While they possess the form of bacteria they are inert and serve as receptacles for the storage of proteid substance by the plant since they were found to be exceedingly rich in protein matter and that later their contents are absorbed by the plant. Because of their morphological resemblance to bacteria Brunchorst termed them bacteroids. He observed the fungus hyphæ but did not consider them to stand in causal relation to the tubercles since he found none

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[42]Beiträge zur Morph. u. Phys. d. Pilze, I.

[43]Sur des Champignons vivant dans l' interieur des cellules végétales, Linnæa, 1842, p. 278. Translated in Ann. Sci. Nat. Bot. II, XIX (1843), 86.

[44]Observations sur certaines excroissances que presentant les racines d. l'aune et d. lupin des jardin. Ann. d. Sci. Nat. Bot. V. VII, 73. See also footnote 28.

[45]Zu dem Aufsatze des Herrn Prof. B. Frank über Parasiten in den Wurzelanschwellungen der Papilionaceen. Bot. Zeit. 1879. p. 537.

[46]Ueber die Knœllchen an den Leguminosenwurzeln. Ber. d. Deutsch. Bot. Gsells. III (1885). 241-257.

in the tubercles of lupines. He as well as Eriksson[47] showed that two types of structure existed, one represented by the tubercles on lupine, and the other by those on peas, etc.

Schindler,[48] Tschirch,[49] Benecke,[50] Van Tieghem and Duliot,[51] and Sorauer[52] supported Brunchorst's view. Tschirch even went farther and considered the fungus hyphæ to represent nothing but preliminary stages in the differentiation of the cell plasma into bacteroids. Lecomte[53] considered that both the hyphæ and bacteroids were receptacles for the storage of albuminous material. Tschirch[54] calls the tissue in which the bacteroids are found "bacteroid tissue."

B. Frank[55] now unreservedly abandons his earlier views of the parasitic origin of the tubercles and holds it proved by Brunchorst that they represent peculiar organs of the Leguminosæ for the storage of proteid substance. He ascribes to the galls on Alnus, Elæagnus, etc., a similar role, while Brunchorst about this time in a preliminary paper[56] and later in a full presentation of his work on Alnus galls finds them to be due to a fungus.[57]

Thus the question hung, as it were, in the balance at the close of what might be termed the middle period of investigations on this subject. But important contributions were soon to be published which would remove all doubt of the causal relationship of the soil organisms to the tubercles.

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[47] Studier œfver Leguminosernas rotknœlar. Lund. 1874. Bot. Zeit. xxxv (1874). 381.

[48] Ueber die biologische Bedeutung der Wurzelknœllchen bei den Papilionaceen. Jour. Landw. xxxiii (1885).

[49] Ueber die Wurzelknœllchen der Leguminosen. Gesells. Naturw. Freunde zu Berlin, and Bot. Centralb. xxxi (1887.)

[50] Ueber die Knœllchen an den Leguminosen-Wurzeln. Bot. Centralb. xxix (1887). 53.

[51] Origine, structure et nature morphologique des tubercles radicaux des Léguminneuses. Bull. d. Soc. Bot. France. xxxv (1888).

[52] Zusammenstellung der neuern Arbeiten über die Wurzelknællchen und deren als Bakterien angesprochene Inhaltskœrperchen, Bot. Centralb. xxxi (1887). 308.

[53] Bulletin d. l. Soc. Bot. d. France. 1888.

[54] Beitræge zur Kenntniss der Wurzelknollchen der Leguminosen. Ber. d. Deutsch. Bot. Gesells. v (1887). 58.

[55] Sind die Wurzelanschwellungen der Erlen und Elæagnaceen Pilzgallen? Ber. d. Deutsch. Bot. Gesells. v (1887).

[56] Ueber die Knœllchen an den Wurzeln von Alnus und den Elæagnaceen. Bot. Centralb. (1880). 354.

[57] Ueber einige Wurzelanschwellungen, besonders diejenigen von Alnus und den Elæagnaceen. Unters. Bot. Inst. Tübingen. ii (1886). 151.

Recent period of investigation.

Ward[58] by a very careful series of inoculations with soil material proves conclusively that the tubercles are caused by some organism which is very abundant in the soil. Frank[59] had even earlier carried out similar experiments which pointed to like results. Ward traces the development of the fungus strands from infection in the root hairs, its growth down into the cortical parenchyma, and into the tissue of the tubercle, where it branches in all directions. He describes and figures the peculiar enlargements where the hyphæ pass through the cell walls, and also enlarged portions of the hyphæ within the cell lumen, characters which we have seen were noted by earlier observers.

On some of these enlarged portions he observed very small buds, or "gemmules," as he termed them, similar to those described by Frank. He considers these the points of origin of the bacteroids, in fact that the bacteroids, or gemmules, are budded off from the hyphæ. According to Ward these gemmules then increased by farther budding within the tubercle. Since there was some correspondence between this supposed development of the gemmules, or bacteroids, with the development of the sporids from the promycelia of some of the Ustilagineæ, and the successive buddings of the sporids in nutrient solutions, as shown by Brefeld,[60] Ward[61] believed the fungus of the tubercles to be related to the Ustilagineæ, but through its peculiar symbiotism with its host, by which the "gemmules" could be preserved through the summer period and then during winter and spring set free by the decay of the tubercles, there was not the need of resting spores such as are found in the known Ustilagineæ, and consequently they had ceased to be produced. About the same time the cultural researches of Hellriegel,[62] Hellriegel

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[58] On the tubercular swellings on the roots of Vicia Faba. Phil. Trans. Royal Society. CLXXVIII (1887). 139–562.

[59] Bot. Zeitung, XXXVII. n. 24–25, 1879.

[60] Botanische Untersuchungen. V. Die Brandpilze I. 1883.

[61] See also, On the tubercles on the roots of leguminous plants with special reference to the pea and bean. Proceed. Royal Society. XLVI. 1889.

[62] Welche Stickstoffquellen stehen den Pflanzen zu Gebote? Tageblatt d. Naturf. Versamml. zu Berlin, 1886, p. 290.

and Wilfarth,[63] and Laws and Gilbert[64] confirmed the investigations of Ward, that the tubercles are due to the action of some organism within the soil.

Ward pointed out that the relation of the low organism to its host was that of a symbiosis, with mutual benefit. Lundstrœm[65] entertains similar views, but left it undetermined whether the lower symbiont was a plasmodium or one of the bacteria.

In 1888 a very important contribution to the biology of the organism was presented by Beyerinck.[66] He undertook the cultivation of the organism in artificial media and claims to have carefully studied the development and morphology of several races or varieties, and in the tubercles he thought he could trace the development of the bacteroids from bacteria. The organism he considers one of the bacteria, and names it *Bacilius radicicola.* Besides the rod forms he describes a motile form of the organism which is very much smaller. He rejected the idea of the presence of fungus hyphæ. These he considered to be the products of nuclear division. Not admitting a hypha as the means of infection he tried to explain the entrance of the organism and its passage from cell to cell by stating that there were invisible pores in the cell walls.

In 1888 Vuillemin[67] published his investigations, the results of which, while maintaining the relation of some symbiont in the tubercles, appear to be quite at variance with others concerning the nature of the organism. His studies of the development of the organism were directed to an examination of certain of the tubercles in the autumn. He observes the fungus threads and interprets the enlargements as sporangia. He claims to have observed the formation of zoospores in the sporangia. These he describes as pyriform, with a cilium at

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[63] Untersuchungen über die Stickstoffnahrung der Gramineen und Leguminosen. Beilageheft z. d. Zeitschr. f. d. Rübenzucker Ind. d. D. R. Berlin, Nov. 1888. Review in Bot. Centralb. XXXIX (1889). 138.

[64] On the present question of the sources of the nitrogen of vegetation, etc. Phil. Trans. Royal Society, CLXXX. B. 1–107. Etat actuel de la question des sources d'azote de la vegetation. Ann. Agr. XIV (1888).

[65] Ueber symbiotische Bildungen bei den Pflanzen. Bot. Centralb. XXVIII (1886).

[66] Die Papilionaceenknœllchen, Bot. Zeit. 1888, p. 725–735, 741–750. 757–771, 780–790, 797–804.

[67] Les tubercles radicaux des Léguminenses, Ann. d. Sci. Agr. Franç. et Etrang. 1888, p. 96.

the smaller end. They conjugate by fusion and form cysts. The non-septate character of the hyphæ taken in conjunction with the formation of zoospores, would ally the fungus with the *Chytridiaceæ* and Vuillemin considered it to be an undescribed species of the genus *Cladochytrium*, and called it *Cl. tuberculorum*. A comparison with Nowakowski's description and figures of *Cladochytrium tenue*[68] shows at least a striking resemblance in the form of the fungus as the hyphæ ramify through the tissues of *Acorus*, presenting here and there intercalary and terminal sporangia.

Vuillemin, with Ward,[69] Lundstrom[70] and Schindler,[71] believes a symbiosis to exist between the fungus and the Leguminosæ. While Lundstrœm classes the tubercles in the category of organs which are the products of mutual association, called by him "domatien,"[72] Vuillemin[73] prefers the name suggested by Frank[74] and calls them "*Mycorhizes endotrophiques*," or "*endomycorhizes*." Ward[75] shows that their inclusion among the Mycorhizæ is as logical as that of Frank's inclusion[76] of Warlich's[77] orchid root fungus.

Frank later[78] distinctly places them, as well as the galls, on Alnus, Elæagnus, etc., among his Mycorhizæ.

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[68] Beitrag zur Kenntniss der Chytridiaceen. In Beiträge zur Biologie der Pflanzen, II (1876). 73-121.

[69] Phil. Trans. Royal Society, CLXXVIII (1887). 539–562.

[70] Ueber symbiotische Bildungen bei den Pflanzen, Bot. Centralb. XXVIII (1886).

[71] Zur Kenntniss der Wurzelknœllchen der Papilionaceen, Bot. Centralb. XVIII (1884). 86.

[72] Ueber Mycodomatien in den Wurzeln der Papilionaceen, Bot. Centralb. XXXIII, 1888.

[73] Remarques sur le memoire de Lundstrœm. Jour. de Botanique, April, 1888.

[74] Ueber die auf Wurzelsymbiose beruhende Ernährung gewisser Bäume durch unterirdische Pilze. Ber. d. deutsch. bot. Gesells. III (1885). 128–144. Neue Mittheihungen über die Mykorhiza der Bäume und der Monotropa hypopitys. Ber. d. deutsch. bot. Gesells. III (1885).

[75] Some recent publications bearing on the question of the sources of nitrogen in plants. Annals of Botany. I. (1887–1888). 325–357.

[76] Ueber neue Mykorhiza-Formen, Ber. d. deutsch. bot. Gesells. V (1887). 395–408.

[77] Beitrag zur Kenntniss der Orchideenwurzelpilze. Bot. Zeitung. XLIV. (1886).

[78] Ueber die auf Verdauung von Pilzen abzielende Symbiose der mit endotrophen Mykorhizen begabten Pflanzen, sowie der Leguminosen und Erlen. Ber. d. deutsch. bot. Gesells. IX (1891). 244-253.

Following close upon Vuillemin's contribution were several by A. Prazmowski, a preliminary paper in 1888,[79] in which he considers the tubercles to be due to a parasitic fungus related to Woronin's *Plasmodiophora brassicæ.*

A second paper appeared in 1889,[80] and the final results of his study of the etiology and development of the tubercles was published in 1890.[81] Prazmowski now believes the tubercles to be due to one of the bacteria and he describes the organism obtained by himself in artficial cultures from the tubercles. By inoculation with the same he succeeded in developing the tubercles. According to him it is a bacterium. In artificial cultures it always develops in the form of simple short rods, which may for a time remain joined in short chains, but it never forms filaments. The rods may farther divide up into short cells, and it possesses a motile form. He denies the presence of fungus hyphæ, regarding them as gelatinous tubes which the organisms excrete to form a protective covering for the mass. The manner of infection through the root hairs agrees in all essential respects with that described by Ward (l. c.), only Prozmowski does not look upon the tube as having any genetic connection with the organism, but simply encloses them while the colony of bacteria directed by a common purpose move along together with the advancing tube down into the tissue of the root. In regard to this unity of purpose exhibited by the colony as described by Prazmowski, his organism would show a relationship to Thaxter's *Myxobacteriaceæ.*[82]

Prazmowski was unable to demonstrate the membranous nature of the tube, while there seems to be pretty good evidence from the experience of Eriksson,[83] Ward,[84] Vuille-

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[79]Ueber Wurzelknœllchen der Leguminosen. Bot. Centralb. XXXVI (1886). 215-219, 248-255, 280-285.

[80]O istocie i znaczeuiu korzeniowych grochu. Berichte aus d. Sitz. d. k. k. Akad. d. Wissensch. in Krakau. June, 1889. Das Wesen und die biologische Bedeutung der Wurzelknollchen der Erbse. Bot. Centralb. XXXIX (1889). 356-362.

[81]Die Wurzelknollchen der Erbse: Erster Theil, Die Ætiologie und Entwicklungsgeschichte der Knollchen. Landw. Versuchs-Stationen. XXXVII (1890). 160-236.

[82]On the Myxobacteriaceæ, a new order of Schizomycetes. Bot. Gazette, XVII (1892). 12.

[83]Studier œfver Leguminosernas rotknœlar. Lund. 1874. Bot. Zeit. XXXV. (1874). 381.

[84]Phil. Trans. Royal Society. CLXXVIII. (1887). 539-562. Proceed. Royal Soc. XLVI (1889). 431-443.

min,[85] Pichi,[86] A. Koch,[87] and Laurent[88] that a membrane does exist.

Short communications by Delpino[89] and Mattei[90] about this time support the view that the tubercles are caused by bacteria.

In 1890[91] Frank appears with still another contribution. While he does not wholly return to his earlier convictions he retraces his steps far enough to once more champion the causal relation of some soil organism. This time he believes the organism to be micrococcoid and names it *Rhizobium leguminosarum.* He still recognizes the two form elements in the tubercles, the hypha-like strands and the bacteroids. The former he believes to be a homogeneous mixture of the cell protoplasm of the two symbionts, in which nothing is visible indicative of the nature of the *Rhizobium* or the protoplasm of the leguminous plant. This mixture he terms *mycoplasm.* Upon treatment with certain reagents the portion of the mycoplasm belonging to the host plant dissolves and sets the micrococci free. Frank also obtained his *Rhizobium* in artificial culture and produced the tubercles by inoculation with the same. The bacteroids he regarded as fragments of the mycoplasm, while in a more recent communication[92] he says they are hypertrophied forms of the *Rhizobium.*

In the same year Laurent published a preliminary paper[93] on this subject, followed in 1891[94] by a more complete exposition of his investigations. He also obtained the organism in artificial cultures and recognizes the genetic connection of the bacteroids and fungus strands, believing with Ward and the earlier tenets of Frank that the bacteroids are budded off

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[85] Ann. d. Sci. Agr. Franç. et etrang. 1888. p. 96.

[86] Alcune osservazioni sui tubercoli radicali delle Leguminose. Atti della Società Toscani di science naturali. 1888.

[87] Zur Kenntniss der Fäden in den Wurzelknöllchen der Leguminoseen.

[88] Ann. d. l'Institut Pasteur. v. (1891). 105–139.

[89] Osservazioni sopra batteriocecidii e la sorgente l'azote in una piante Galega officinalis. Malpig. II. fasc. 9–10. (1889). Cited by Prazmowski.

[90] Ancora sull' origine della Vicia faba. Bologna. 1887. Cited by Vuillemin.

[91] Ueber die Pilzsymbiose der Leguminoseen. Berlin, 1890.

[92] Berichte d. deutsch. bot. Gesellsch. IX. (1891). 244–253.

[93] Sur le microbe des nodosités des Légumineuses. Compt. Rend d. Sc. Paris. 1890. pp. 754–756.

[94] Recherches sur les nodosités radicales. Ann. d. l'Inst. Pasteur. v. (1891). 105–139.

from the hyphæ. He treats of the organism as a yeast form, and while in his artificial cultures a large number of the individuals were rod-like, some presented an irregularly lobed form. These forms together with the development of the bacteroids from the hyphæ he judges separates the organism from the true *Schizomyceteæ*. He accepts Frank's name *Rhizobium leguminosarum*, but believing it to be related to Metschnikoff's *Pasteuria ramosa*,[95] he locates it in the *Pasteuriaceæ*.

During the last year an article on this subject has appeared from an American writer.[96] The original part of Schneider's paper deals with the morphology of the bacteroids of several leguminous species, the variations in form of the bacteroids alone seeming in the estimation of the author sufficient ground for the characterization of species, and several species and varieties are named. Schneider accepts Frank's generic name *Rhizobium*, but rejects his theory of a mycoplasm. He denies the genetic connection of the bacteroids with the hyphæ, and definitely rejects the idea of any causal relation of the fungus hyphæ to the tubercles. He observes fungus threads in the tubercles, but cannot differentiate them from fungus threads which he finds in other parts of the roots where there are no tubercles.

[*To be concluded.*]

Cornell University.

BRIEFER ARTICLES.

Two new plants from Washington.—Allium Hendersoni.—About a foot high: bulb white, ovate, 6–7 lines in diameter, finely but indistinctly reticulated: leaves 2, linear-oblong, attenuate, thickish, 4–6 inches long, as many lines broad: scape rather stout, much exceeding the leaves: umbels many-flowered, globose: spathe 3-parted; bracts ovate, acuminate, 6–8 lines in length: pedicels 8–10 lines long: segments of the perianth rhombic-ovate, acuminate, 3–4 lines long, purple, with light midrib: stamens exserted: ovary 6-crested: seeds dull black, compressed, obovate, 1½ lines in length.—Collected near Pull-

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[95] Pasteuria ramosa, un représentant des bactéries a division longitudinale. Ann. d. l'Inst. Pasteur. II. (1888.) 165–170.

[96] Observations on some American Rhizobia. Bull. Torrey Bot. Club XIX. July, 1892.

man, Washington, June, 1892, by Prof. Louis F. Henderson, (n. 2,482) and in a neighboring locality and same month by Mr. W. R. Hull (n. 621).

Near *A. Lemmoni* Wats. but differing in the relatively much shorter and broader leaves, much more numerous flowers, distinctly exserted stamens and 3-parted spathe; differing from *A. platycaule* Wats. in its taller scape, shorter and broader perianth segments and crested ovary.

Calochortus ciliatus.—Low, 6–8 inches in height, branched above: bulb ovate, ½ an inch in diameter: leaf solitary, 2½–3 lines broad, equalling the 4–8-flowered stem: bracts linear, attenuate: flowers rather small: sepals ovate, acuminate, greenish-white, scarious-margined, 4–6 lines long: petals of equal length, light bluish-purple, paler towards the edges, triangular-lanceolate, rather abruptly narrowed at the base, conspicuously ciliate, glabrous except the yellow doubly fringed lunate scale of the gland: stamens half as long as the petals: anthers oblong, sagittate, apiculate, 2–2½ lines in length: capsule elliptical in outline, acutely 3-winged, 7–8 lines long.—Collected by T. S. Brandegee, Wenatchie Region, Washington, July, 1883 (n. 1,107), and by Prof. L. F. Henderson on grassy slopes among pines, upper Nachez river, Yakima co., Washington, June, 1892 (n. 2,485).—B. L. ROBINSON and H. E. SEATON, *Gray Herbarium, Cambridge, Mass.*

EDITORIAL.

THERE IS an extraordinary diversity of usage in the matter of citation of references, much more than would be imagined by those who have not directed their attention to it. Writers who would be unsparing in their condemnation of carelessness in observation or experiment are strikingly careless in their citation of the work of others. Some papers on the contrary which have less value in themselves are characterized by such complete and accurate bibliography that they become valuable in spite of their scanty additions to knowledge.

It seems to us that the cardinal rule that should govern citations is that papers should be so cited that they can be found with the least possible expenditure of time and trouble by one who wishes to consult them. What information is indespensable will vary with the nature of the publication. For instance the citation "Bot. Gaz. 1890. 132" would enable one to find a given paper; but the citation "Bot. Centralb. 1890. 132" would not, since there are four pages bearing that number in the four volumes for 1890. If it were so cited the seeker might have to examine all of these before finding the one desired.

But even "Bot. Gaz. 1890. 132" is not adequate to the most ready finding of the reference. In binding such journals many libraries indicate on the back only the number of the volume. If the year only were cited two volumes or more might have to be taken down, whereas if the citation "Bot. Gaz. XVI (1890). 132" the paper could be found with the greatest ease, since no data are lacking.

In our opinion the following items should be given in a full citation: (1) the title of the article; (2) the name of the publication, if abbreviated at all abbreviated so as to be readily identified ("Jour. Bot." would not be so); (3) series number, if any; (4) volume number; (5) year; (6) page. Designating the part, heft, lieferung or fascicle is generally useless.

For the sake of greater uniformity of typography the GAZETTE has tentatively adopted that shown in the following samples. It would be a convenience if authors would follow this plan, or would agree upon some other in this time of botanical agreements.

VAN TIEGHEM et DOULIOT: Les racines des phanérogames. Ann. Sci. Nat. Bot. VII. VIII. (1891). 256.

VAN TIEGHEM: Traité de Bot. II. 398. Paris. 1891.

CURRENT LITERATURE.

Sachs' Writings on Vegetable Physiology.

In the domain of vegetable physiology there is one name that stands high above all others. It is that of Dr. Julius von Sachs, the eminent professor of botany in the University of Würzburg. He is not the father of the science, that honor belonging to Stephen Hales, an Englishman of a century ago, but he is its deliverer, having rescued it from an inconsequential condition, in which it received slight consideration, and by his rare insight and acute experimentation, his breadth of view and solidity of judgment, and especially by his ability in coördination, having placed it among the foremost of the several divisions of the science of botany. At the time he began to write more physiological work was done by chemists and physicists than by botanists, and the subject was not taught as a separate study; now laboratories and chairs are often exclusively devoted to it, and it has risen to equal dignity with the other departments of botany.

The writings of Dr. Sachs, which are the basis of this advancement, and to which every investigator must refer who desires to examine the original publication of facts discovered during the last thirty-five

years, are scattered through many journals and proceedings of societies, as is the case with the writings of most authors, and it was an act of special consideration for the learned author to devote some of the time of his declining years to the collection and editing of the most important of his writings. The result we now have in a heavy volume[1] of over twelve hundred pages. The publisher has issued it in two parts (erroneously called volumes on the title page), with continuous paging and single index. Forty-three memoirs are included, the principle of selection being to take those which deal most fully with observation; for while theories and explanations are subject to continued variation, true facts remain immutable. The original publication of the articles dated from 1859 to 1892. In the collected form the chronological arrangement is not closely adhered to, but a certain sequence of topics is maintained under the following headings: physical and chemical phenomena of vegetation, growth, formation of cells and irritability. Unimportant parts of the original articles have been omitted, but no additions have been made, except when an explanation seemed to be needed to show the connection with the present state of knowledge, and such additions are always distinctly indicated.

These memoirs supplement and substantiate the author's text-books. It is impossible to more fully outline here the interesting contents of this large volume, and it must suffice to say, what is but simple fact, that it will prove indispensable to the student of vegetable physiology, not only on account of the invaluable memoirs it contains, but because of the convenient form in which they are presented.

Minor Notices.

THE SECOND VOLUME of Massee's British Fungus-Flora[2] is now issued, and is an exact counterpart of the first volume, noticed in the January issue of this journal (p. 31). A few more species are included, than in the first volume, making nearly 1,600 species in both. The present volume does not yet carry the work through the Basidiomycetes. As the work is to be completed in three volumes, we are at a loss to see how the author can justify his selection of a title. If the third and concluding volume is like the preceding ones, there will yet remain 2,500 species of the "British fungus-flora" unprovided for, if by that term is meant the species of British fungi. That is, in a work

[1] SACHS, JULIUS.—Gesammelte Abhandlungen über Pflanzen-Physiologie. pp. x. 1,243. pl. 10, figs. in text 126. royal 8vo. Leipzig, Wilhelm Engelmann, 1892-93. Marks 29.

[2] MASSEE, GEORGE.—British fungus-flora: a classified text-book of mycology. 3 vols. Vol. II. pp. 432. Illustrated. 8vo. London, George Bell & Sons, 1892.

which purports to cover the whole field of the British fungous flora, and to be a "classified text-book of mycology," only half of the known species of fungi found in the region are included. However, the author may have some way of avoiding the dilemma.

A VALUABLE monograph upon the American species of Saprolegniaceæ has recently been published by James E. Humphrey.[1] It appears in the Transactions of the American Philosophical Society, but has also been distributed separately. The group was greatly in need of study, and it is gratifying to have the labor so handsomely and so substantially done. The author found little material upon which to begin his work, and with the exception of some aid from a half dozen collectors, chiefly from the material gathered over ten years ago by Dr. William Trelease, he was dependent upon his own collections made during the two years given to the study. Considerable space is devoted to the morphology of the group. Under the head of classification twenty-one species are described, belonging to seven genera. These include six new species, while the study of European forms not yet found in America has led to the separation of a new genus, and the change of name of two species. The seven lithographic plates are particularly fine, and will be a great help in future study. This work will undoubtedly give a decided impetus to the study of these more than usually interesting aquatic fungi. An extensive bibliography completes the paper.

A BIBLIOGRAPHY of the tannoids covering 27 pages and including over 450 entries has been prepared by J. Christian Bay, and distributed as a reprint issued in advance of the fifth annual report of the Missouri Botanic Garden. The author published a bibliography of inulin recently, and proposes to follow with other subjects. Such works are of the greatest value to investigators, and their preparation should receive the utmost encouragement from every botanist.

THE ARTICLE UPON BOTANY in pharmacy by John S. Wright in a recent number of *Science* has been reprinted with additional illustrations and distributed by Eli Lilly & Co. in the form of a neat pamphlet.

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[1] HUMPHREY, J. E.—The Saprolegniaceæ of the United States, with notes on other species. From Trans. Amer. Phil. Soc., XVII. pp. 63–148. pl. XIV–XX. 4to.

OPEN LETTERS.

A misunderstanding corrected.

Some time ago I was informed by a friend that Prof. Conway MacMillan in the introduction to his "Metaspermæ of the Minnesota Valley," had credited me with holding some remarkable views on the subject of botanical nomenclature that certainly had never occurred to my mind. I had some difficulty in consulting the book in question, as copies of it do not seem to be abundant in this part of the country, but finally succeeded in borrowing a copy for a somewhat hasty examination. I then found to my surprise that the author had cited me as an authority for the proposition that botanical nomenclature should be passed upon by a non-scientific commission, and referred to a communication of mine printed in the GAZETTE, XVI, 4, to support his statement. I am very sorry that any one could have so misunderstood my meaning, for my plea was for nothing of the kind. It was only for more intelligent appreciation of actual, practical needs, and present difficulties, and for more judicial and fair-minded consideration and less partisanship. I have faith enough to believe that there are in this country, as there certainly are in other countries, able botanists who are also men of affairs and men of sound judgment, men who can look beyond the walls of the herbarium and can realize that a theory should be subordinated to practical necessities. When the supply of such botanists fails us, it may then be time to consider the expediency of referring the question of botanical nomenclature to a non-scientific commission; but until then I should not wish to advocate such a treatment of the question even if I were as unthinking and unbotanical as Prof. MacMillan appears to consider me. Although men of intelligence and of practical acquaintance with the general laws of nomenclature are undoubtedly competent to pass on the nomenclature of a science to a certain extent, yet no one would claim for them alone the right to absolute and final decision of its problems.

While I consider that Prof. MacMillan's book reflects great credit on his industry and genius for compilation, yet, as a model local flora, it seems to me a number of steps in the wrong direction, especially in this case where, as the author himself states, the work is addressed to the people. As the book stands, an abridged or expurgated edition really appears to be a necessity if the volume is intended for popular use. I cannot, moreover, help regretting that the learned author has laid his work open in so many ways to the knife of an impartial critic, not to mention the assaults of an opponent. In such respects the book shows more partisan than judicial spirit—a failing much to be deplored in a work presumably printed at the public expense, and from which the public consequently has a right to demand a fair and impartial statement of disputed questions.—EDWARD L. RAND, *Boston.*

NOTES AND NEWS.

TWENTY-ONE new species of Canadian parasitic fungi are described by J. B. Ellis and J. Dearness in the *Canadian Record of Science* for January.

DR. W. JANNICKE, lecturer on botany in the Senckenberg Institute at Frankfort on the Main, died the latter part of March. Dr. Möbius of Heidelburg has been elected to the position thus made vacant.

THE MARINE BIOLOGICAL LABORATORY at Wood's Holl, Mass., opens its sixth season on June 1st. The botanical laboratory for teachers and students will open July 5th, in charge of Dr. W. A. Setchell, instructor in botany, Yale University, and W. J. V. Osterhout, of Brown University.

M. MAURICE GOMONT publishes in the *Annales des Sci. Naturelles* VII. XVI. 91–256 the second part of his Monograph of the Oscillarieæ, including the second tribe, the Lyngbyeæ. The work seems to bethoroughly done, the full citation of synonymy (which is copious) and the keys to the genera and species being especially serviceable.

THE FIRST SESSION of the Hopkins Seaside Laboratory, of the Leland Stanford University, held during last summer, was a very successful one both in the attendance and in the results accomplished. The great advantages which is was thought the location selected would afford more than met the most ardent expectations when brought to the actual trial. The course of instruction for the session of 1893 will open June 5th and close July 15th, though investigators and advanced students may arrange to continue their work for a longer period. The coming session will open with a better equipment, improvement in the buildings and the more intimate knowledge of the collecting grounds resulting from a year's experience in the locality. The building provided is a plain two-story frame structure, 60×20 feet, located on a low bluff immediately overlooking the beach at Pacific Grove near Monterey, where the variety and abundance of marine life is exceptionally great.

AMONG THE station bulletins received in the last month the following are of botanical interest. "Canaigre" (Rumex hymenosepalus) by Collingwood, Toumey and Gulley (Ariz., no. 7) has its economic value as a source of tanning material. The history, botanical and chemical characteristics, and cultivation are fully treated. "Conditions affecting the value of wheat for seed" and "Prevention of potato scab" by H. L. Bolley (N. D., no. 9) form an interesting bulletin of 41 pages. The first subject deals with the injury to seed grain caused by freezing, over-heating, immaturity, etc., and the second with the corrosive sublimate and other methods of controlling potato scab. "Preliminary report on rusts of grain" by A. S. Hitchcock and M. A. Carleton (Kans., no. 38) is chiefly devoted to the effect of various chemicals upon the germination of uredospores. "Some diseases of cotton" by Geo. F. Atkinson (Ala., no. 41) is quite an exhaustive treatise of 65 pages. "Some celery diseases" (N. Y., no. 51) is a good account of this subject. Although no author is mentioned it is probably to be credited to S. A. Beach. All the above papers are amply illustrated.

The Journal of the Quekett Microscopical Club, a quarterly publication, is issued under the editorship of Edward M. Nelson since the death of Henry F. Hailes, which occurred last October. Mr. Hailes had been the editor for nine years.

Dr. F. Pax, who was formerly connected with the Botanic Garden of Breslau, but more recently custodian of the Botanic Garden of Berlin, has been tendered the position of Professor of Botany in the University of Breslau and Director of the Botanic Garden to succeed Dr. Prantl, deceased.

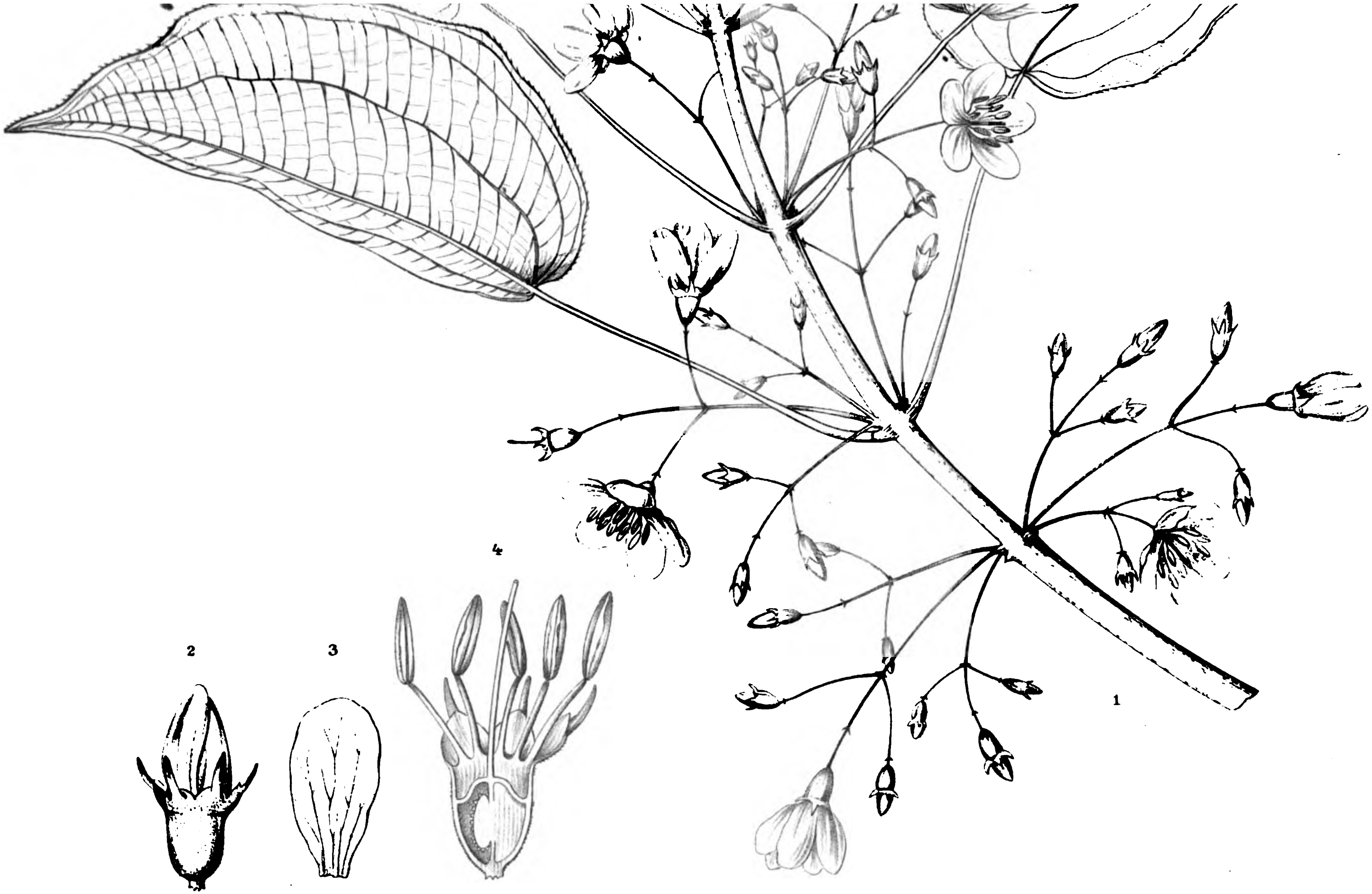
A long list of new species of fungi is given by J. B. Ellis and B. M. Everhart in the Proceedings of the Philadelphia Academy of Sciences, under date of Feb. 28th, being pages 128 to 172. It is also issued separately. There are described 53 Pyrenomycetes, 24 Discomycetes, 11 Uredineæ, 2 Ustilagineæ, 46 Sphæropsideæ, and 13 Hyphomycetes, making a total of 149 species.

The summer courses of instruction in the Cornell University begin July 6th and continue to August 16th. The botany is under the charge of Mr. W. W. Rowlee. Four courses are offered: 1, general course; 2, systematic work, especially with composites and grasses; 3, histology; and 4, study of cryptogams. The fee is $20 for one course, or $30 for two, with the cost of laboratory material added.

The tenth annual report of the Massachusetts state experiment station for 1892 contains the report of J. E. Humphrey (pp. 211–247), dealing with plant diseases. It includes several diseases of cucumber, a violet Phyllosticta, black knot of plum, grain rusts, and various mildews. The account of Sclerotinia Libertiana on cucumber is especially interesting. Five excellent plates accompany the report.

The Indiana Academy of Science held its annual spring field-meeting at Terre Haute, May 17th and 18th. The plans for a complete biological survey of the state were perfected, and their execution entrusted to a board ot directors, consisting of three members to represent the departments of zoology, botany and paleontology. The first report will be made at the winter meeting, next December. Prof. L. M. Underwood of De Pauw University was chosen director in charge of botany.

The annual report for 1892 of the Connecticut experiment station contains the report (pp. 36–49) of the mycologist, W. C. Sturgis, devoted largely to treatment of plant diseases. Spraying of potatoes and quinces with copper compounds, and the prevention of injury to asters and other plants by nematodes are the chief topics. The report for 1892 of the Storrs experiment station of Connecticut contains an account (pp. 17–22) of experiments upon the fixation of free nitrogen by plants, peas being used, conducted by W. O. Atwater and Chas. D. Woods. It also contains the fourth report of H. W. Conn upon bacteria in milk (pp. 106–126), giving the course of experiments which resulted in the separation of an enzyme from several species of milk bacteria, that possesses the same physiological action as animal rennet.



C. E. Faxon, del. B. Meisel, Lith Boston.

CLIDEMIA CYMIFERA, Donnell Smith.

C. E. Faxon, del.

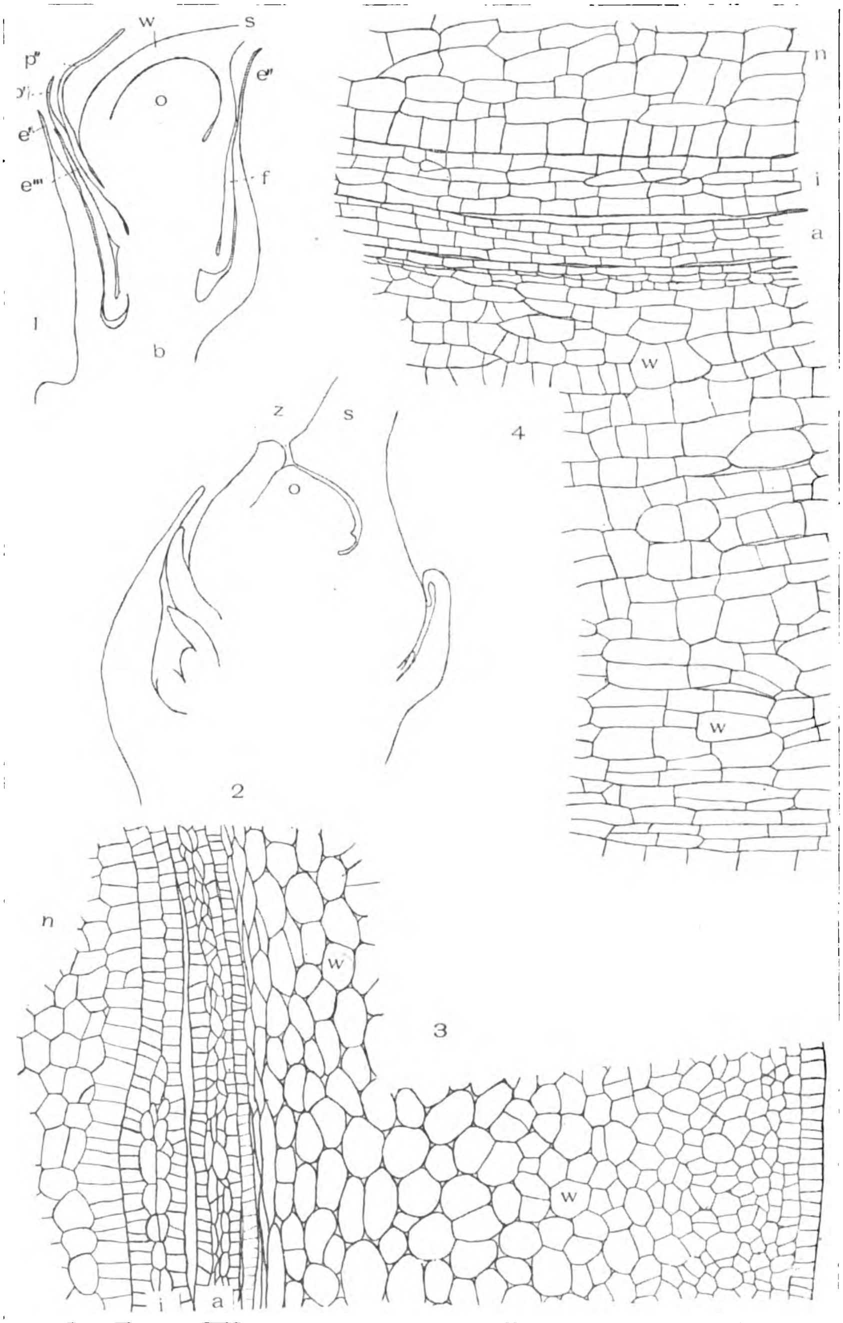
B. Meisel, Lith. Boston

TYNANTHUS GUATEMALENSIS, Donnell Smith.

C E Faxon, del

B Meisel, Lith. Boston

APHELANDRA HEYDEANA, n. sp.



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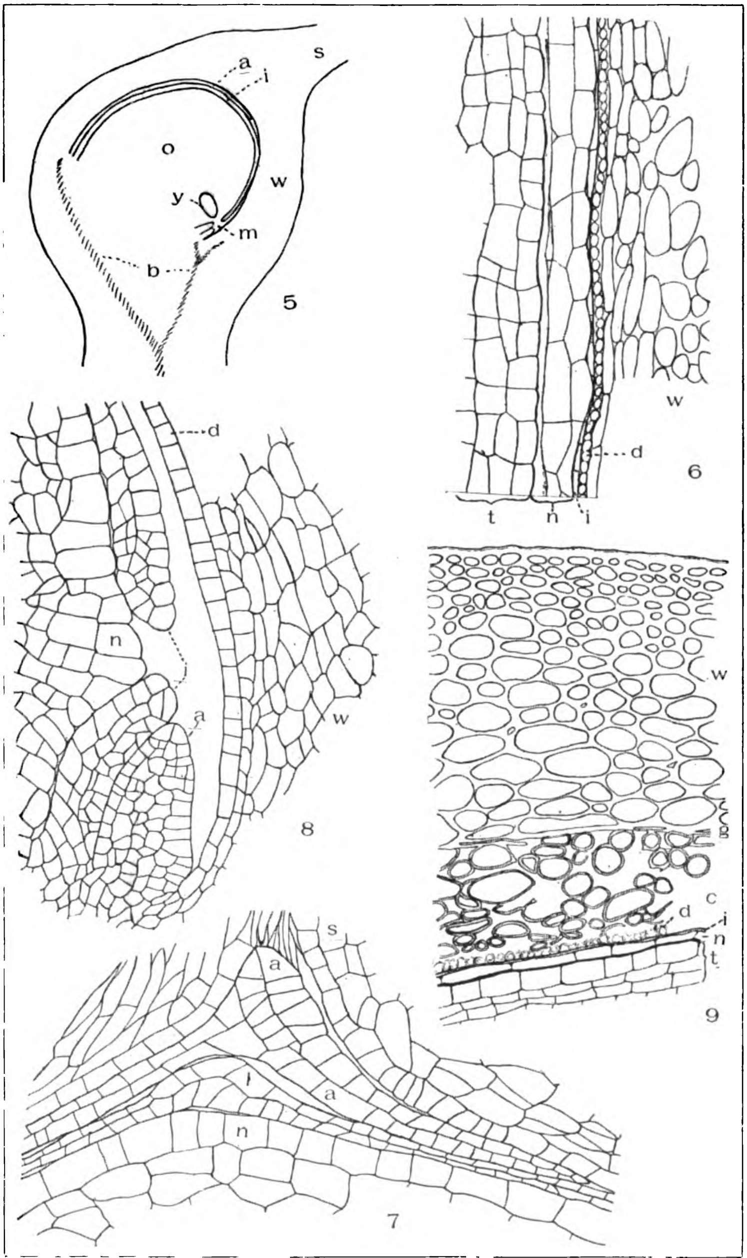

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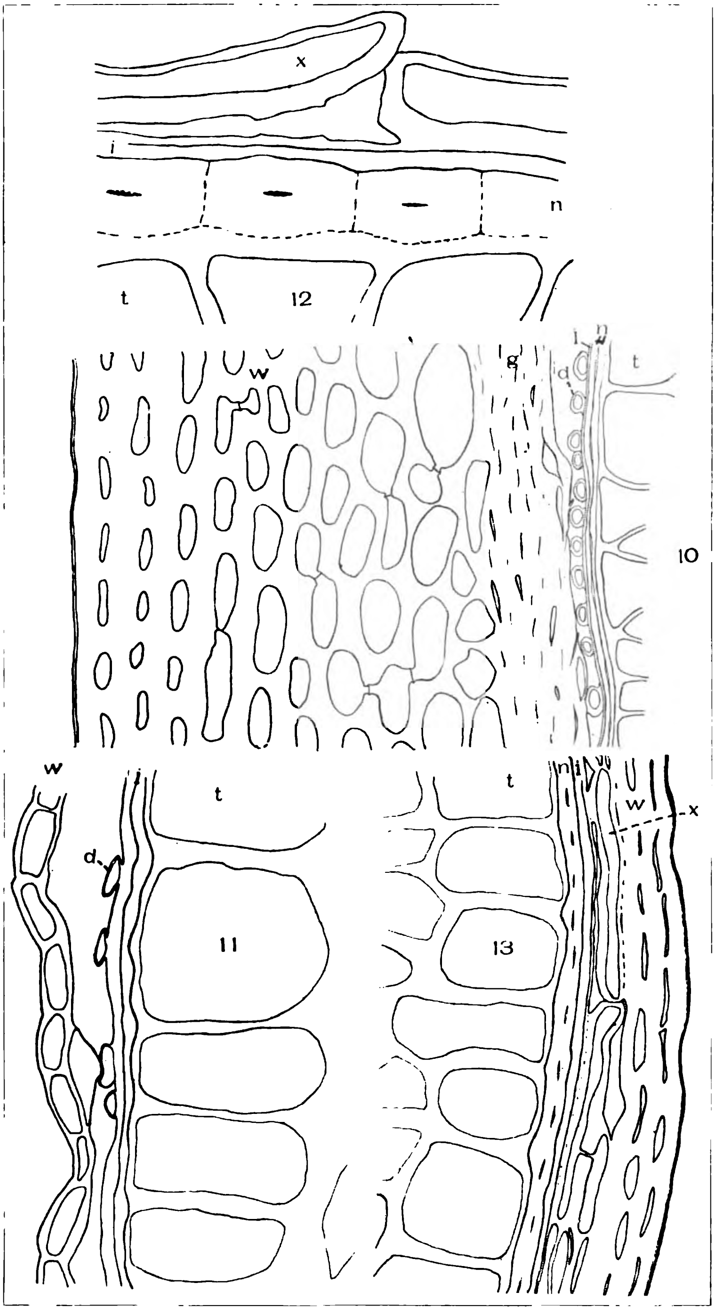

TRUE on the CARYOPSIS.

BOTANICAL GAZETTE

JULY, 1893.

On the embryo-sac and embryo of Senecio aureus L.

DAVID M. MOTTIER.

WITH PLATES XXVII–XXIX.

We are made familiar with the structure and development of the embryo-sac and the process of fertilization in the angiosperms by Dr. Eduard Strasburger in his masterly works, "Angiospermen und Gymnospermen," "Zellbildung und Zelltheilung," and "Theorie der Zeugung." Of the great number of plants taken as illustrative types in only one of the Compositæ are the details of the development of the embryo-sac given, namely, *Senecio vulgaris*. The Compositæ, and, it may be said, the dicotyledons in general, present many difficulties in the study of these processes.

I have observed, however, that *Senecio aureus* L., a very common native American species, is a very favorable object for the study of the embryo-sac and the early stages in the development of the embryo. Work upon this plant was undertaken chiefly for the purpose of comparison with that which obtains in some of the lower dicotyledons and monocotyledons and to see whether the process here differed in any way from that of the allied species, Senecio vulgaris, according to the account given by Strasburger.

According to our present state of knowledge the typical seven-celled embryo-sac is a structure that stands isolated in the plant kingdom. Whether this is the same for all angiosperms is not known, and, if any variation from the type exists, it is highly probable that it occurs in some of the lowest dicotyledons or monocotyledons. Unfortunately, however, in none of the lowest of those forms is the development of the embryo-sac known, and a study of this process in the lowest forms of the above named groups is beyond question necessary.

Since my results agree closely with those of Strasburger upon *Senecio vulgaris* a brief *résumé* of the latter may be for convenience given here.[1]

As will be indicated below, I am here concerned only with the nearly mature and mature embryo-sac, and such facts only as pertain to it will be mentioned. In the nearly mature embryo-sac the two synergidæ occupy the entire forward pointed end of the embryo-sac. Under these lies the egg, occupying usually the entire diameter of the embryo-sac. The antipodal cells completely fill the hinder end of the embryo-sac. They lie in a longitudinal row, or two above and one below. The lower antipodal cell gives rise to a large hinder vacuole as a cell lumen. Its nucleus lies in the protoplasm lining the wall, at about one-half the height of the cell lumen. The two nuclei given off to the inner part of the embryo-sac approach each other quickly to unite just as the embryo-sac approaches maturity. When this state of maturity is reached the embryo-sac swells considerably at its middle part. The synergidæ have now rounded themselves off somewhat at the forward end, and appear here strongly refractive. Their nuclei lie in the hinder third. By the swelling of the embryo-sac, the egg has become free at its hinder part. The lowest antipodal cell usually divides once before the mature state is reached, so that there are now four antipodal cells. Frequently, however, only the nucleus divides without being followed by a cell division.

The embryo-sac.

In preparing the material for this work heads of flowers were gathered in the stage of development desired, halved and treated for about twelve hours (usually over night) in a one per cent. aqueous solution of chromic acid. After thorough washing, they were gradually brought into ninety-five per cent. alcohol. The material was stained *in toto* with alum cochineal, imbedded (through xylol) in paraffin and sectioned on a Minot microtome. The sections were counter-stained on the slide and mounted in balsam. In this way serial sections were made of a large number of florets, and not infrequently were several stages of the young embryo obtained upon a single slide as well as mature embryo-

[1] Angiospermen und Gymnospermen, 1879, pp. 9, 10, 11. Zellbildung und Zelltheilung, dritte Auflage, 1880. pp. 42, 43.

sacs. We are concerned here with the mature embryo-sacs, and with that stage in the development just before the nuclei given off to the interior, unite to form the endosperm nucleus. The earlier stages in the development observed agree with that which obtains in Senecio vulgaris according to Strasburger and will not be repeated here.

The two synergidae and egg-cell occupy the somewhat anterior pointed end of the embryo-sac (figs. 2, 3, 8, 9.). The synergidæ are somewhat pear-shaped, being narrower at the anterior end, where they are also rounded. In all cases observed the anterior ends of the synergidæ never appeared refractive, but filled with granular protoplasm which stained only slightly with alum cochineal, but stained readily with Bismarck brown. The posterior part of each of the synergidæ is occupied by a large vacuole which reaches fully half the length of the cell and probably extends farther forward than it seems. The vacuole does not take up the entire posterior part of the cell, but a delicate layer of protoplasm forms an inner lining of the cell. The nuclei lie imbedded in this protoplasmic lining about midway between the anterior and posterior ends. In no case were they observed in the posterior third as Strasburger states for Senecio vulgaris.

The egg-cell is similar in form to the synergidæ, though inserted a little lower, the posterior part occupying, in the many cases observed the entire diameter of the embryo-sac. The protoplasm is accumulated in the posterior end in which is imbedded the egg-nucleus, while the vacuole is in the anterior end. Thus in the egg-apparatus there is a sort of equilibrium maintained in the distribution of the protoplasm. The nucleus has a large nucleolus which stains so deeply with alum cochineal as to appear a homogeneous red, except there is invariably present from one to several highly refractive bodies resembling drops of oil. This may be due to the reagents used in preparing the tissue for sectioning and not to normal products of the nucleolus. Surrounding the nucleolus is a zone of slightly stained protoplasm, and finally the nuclear membrane which appears with great clearness. The nucleus is usually spherical though frequently compressed on one side, due probably to contraction caused by reagents (fig. 10). In nearly all preparations there was no shrinkage whatever.

When the embryo-sac is mature it swells considerably at its middle, so that the egg-apparatus is free behind.

The antipodal cells occupy the entire posterior end of the embryo-sac, which is narrow and always remains so (figs. 5, 7, 13). As in Senecio vulgaris, they lie in a longitudinal row (fig. 5), or one below and two above (figs. 1, 3); but I find here a much greater variation in the number of cells than Strasburger figures for Senecio vulgaris. In several instances only two cells were present (fig. 7), separated by a much swollen wall. The lower cell is longer than the upper and the nucleus is greatly lengthened in the direction of the axis of the embryo-sac; it contains several nucleoli and may have arisen from the fusion of two nuclei. Fig. 3 shows an embryo-sac in which the lower antipodal cell has divided, and in the upper one of these the nucleus has doubled. The doubling of the nuclei in the antipodal cells is, however, a frequent occurrence. In fig. 4 it will be seen that each antipodal cell has divided, making six in all. A curious condition of things is shown in fig. 6. The wall, x, was well developed, but the others, x', x', were extremely delicate.

In many cases the walls separating the antipodal cells were slightly swollen (fig. 5). These facts seem to indicate that the antipodal cells represent a structure that shows a tendency toward further development, suggesting a much reduced prothallium or rudimentary structure of some kind, and a comparison of it with a prothallium of the vascular cryptogams seems reasonable.

The fusion of the two nuclei to form the endosperm nucleus takes place after the formation of the egg apparatus and antipodal cells. In no case were the antipodal cells observed lying free without cell walls at the time when the nuclei were about to unite to form the endosperm nucleus; the walls were always well developed at this stage.

Of the two nuclei given off into the cavity of the embryo-sac, the one which comes from the antipodal end traverses the greater distance and meets its fellow close to the egg-cell where they unite (fig. 1). The endosperm nucleus invariably lies very near the egg, apparently touching it in many cases (figs. 4, 8, 9, 10). Its structure is similar to that of the egg nucleus, except it is much larger in every respect. It is surrounded by rather dense granular protoplasm from which radiate delicate threads connecting with the very delicate layer of protoplasm lining the cavity of the sac. In this particular fig. 9 is the most interesting. Here a very

beautiful net-work of protoplasm seems to radiate from the region of the egg nucleus, though between it and the observer, almost obscuring the endosperm nucleus lying beneath.

Fertilization.

Senecio aureus is by no means a very favorable object for the study of the process of fertilization. As is well known, the dicotyledons as a rule, present here many difficulties. Either the ovules are opaque, necessitating sectioning, or the nuclei in the pollen tube as well as the tube itself are extremely small. In Senecio aureus and the Compositæ in general both of these difficulties confront the observer. However, by the aid of a 2^{mm} oil immersion I was enabled to demonstrate the presence of the pollen tube in the micropyle and the generative nucleus after it had entered the egg-apparatus. In no case was the presence of a pollen tube in the style or any part of the ovary wall observed, consequently the exact path followed by it was not determined. The end of the tube was seen just as it had reached the anterior ends of the synergidæ (figs. 7, 8, 9, 10). Its membrane is extremely delicate and the tube collapses soon after the contents have left it. The contents now spread out upon the anterior ends of the synergidæ, make them appear more densely granular (figs. 8, 9). The generative nucleus as it leaves the pollen tube, appears as a very small and slightly stained mass of nuclear substance (fig. 8). By the time it has reached the egg nucleus, however, it has increased considerably in size (fig. 10), having been nourished by the contents of the egg apparatus. In the preparation represented in fig. 9, the presence of a pollen tube was quite evident, the anterior ends of the synergidæ densely granular, but no definite nucleus could be seen. Two small bodies more densely stained than the rest are present, which take on the character of nuclear substance.

The wall of the micropyle just in front of the synergidæ stained a homogeneous brown (not shown in the figures), suggesting strongly the presence of a mucilaginous substance, which in all probability is secreted by the synergidæ. In fig. 10 the generative nucleus is seen lying close to the egg-nucleus. In fig. 11, two, though smaller, nuclei are seen. Even at this stage in the process, the synergidæ seemed very little changed, except their membranes were extremely del-

icate and almost indistinguishable. In fig. 11 the synergidæ on the left showed disorganization, the nucleus being smaller and vacuole larger.

Development of the embryo.

The fertilized egg, oospore, increases in size, becomes slightly elongated, and develops a more definite membrane (fig. 12). The posterior part (that directed toward the micropyle) now protrudes slightly into the micropyle to serve as an organ of attachment. The nucleus increases now greatly in size as does the endosperm nucleus also. The synergidæ are almost entirely absorbed; their remains are shown in the figure. The oospore now divides near its upper end (that directed away from the micropyle) by a transverse wall into a terminal hemispherical cell and a basal cylindrical cell (fig. 13). The terminal cell forms the greater part of the future embryo, while the basal cell forms the suspensor and a part of the embryo. This differs from that which obtains in *Capsella*[2] in that the oospore does not elongate into a tube which first divides by a number of cross walls to form the suspensor. Here the suspensor remains shorter; it is composed of fewer cells and the divisions take place later. At this stage of development (fig. 13), several free nuclei have arisen in the cavity of the embryo-sac from the division of the endosperm nucleus.

This terminal cell of the embryo, after further increase in size, divides into halves by a longitudinal wall. This is followed by a second longitudinal wall at right angles to the first, as will be seen in a cross section of the same at a similar stage of development (fig. 19). A third wall, transverse, follows at right angles to the first two. The terminal cell has now divided into eight cells, which may be compared to the octants of a sphere. From the upper half of the embryo which is cut off by the transverse wall, proceeds subsequently the epicotyledonary (plumule and cotyledons) portion of the embryo, and from the lower, the hypocotyledonary (radicle) portion. At this stage of development (fig. 14) a cell is cut off from the upper end of the suspensor by a transverse wall. This cell, x, subsequently contributes to the formation of the periblem of the root, the root cap and suspensor. The three walls mentioned above which divide the original terminal cell

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[2]Goebel: Outlines of Classification and Special Morphology, English translation, 1887, pp. 396, 397, 398.

of the embryo into octants follow each other rapidly; for in different flowers of the same head, embryos as represented in fig. 13 were very frequently found along with those developed as far as shown in fig. 16 or farther. The stage figured in fig. 14 was rarely met with.

The usual form of the embryo at this stage of development is that which is figured in figs. 17, 18, the figures representing longitudinal sections.

Each of the four upper cells of the embryo is now divided into two by anticlinal walls (fig. 16). Immediately following this each cell of the embryo is separated into an inner and outer cell by its periclinal wall (figs. 18, 21). The outer row of cells is the dermatogen or young epidermis; its cells divide henceforward only by walls at right angles to the outer surface, i. e., anticlinal walls, no periclinal walls being formed. The inner cells are the initial elements of the periblem and plerome, which are very early distinguishable from each other. This may be plainly seen in fig. 22, and in fig. 20, which is a cross section of a young embryo. The cells of the periblem and plerome now divide by both longitudinal and transverse walls, the divisions being quite regular for a time (figs. 22, 23), but as the embryo increases in size they become less regular (fig. 25).

The cell divisions which take place in the cell *x*, fig. 14, do not seem to follow with as great regularity as in Capsella. It divides once or twice by transverse walls (figs. 18, 21, 23, 24), and the cells thus formed divide further by longitudinal walls, though with no great regularity (figs. 22, 24). Whether any cell or cells are cut off from the upper part of the large cell of the suspensor could not be determined, as the nucleus was not seen in process of division. However, as above stated, it contributes to both embryo and suspensor.

The suspensor consists of few cells, usually three or four, the lower one remaining large and cylindrical, and projecting slightly into the micropyle (figs. 18, 22, 25). In fig. 26 the first appearance of the cotyledons is seen; the limits of periblem and plerome are indicated by heavy lines. Thus at this stage of development those parts which are to become the root, stem and cotyledons are quite apparent (figs. 25, 26); even as early in the development as represented in figs. 21, 22. Further development of the embryo was not followed.

The endosperm.

As stated in the foregoing, several free nuclei appear in the cavity of the embryo-sac when the first wall is formed in the embryo. Very soon, however, cell formation takes place, and the cavity of the embryo-sac is entirely filled with endosperm (fig. 18). In some cases the embryo was further developed than others before cell formation took place in the endosperm. The process of cell building here is that of the Capsella type.[3] This is not a favorable object for the study of the details in the process of cell-formation. I was not able to make out the "Verbindungsfäden" of Strasburger.[4] Fig. 27 shows two endosperm cells that occupied the whole width of the embryo-sac in which was the embryo, fig. 16. Figs. 27 and 16 were taken from consecutive sections. Around each nucleus (fig. 27) whose membrane is somewhat contracted, is an accumulation of protoplasm from which radiate delicate protoplasmic threads.

The endosperm cells are relatively large and not very rich in protoplasm. The layer of cells forming the wall of the embryo-sac, which is the modified adjacent part of the integument of the ovule, is rich in protoplasm, nuclei and contents staining densely with cochineal stain. The neighboring cells of the integument soon begin to disorganize (fig. 18).

Very noticeable is the fact that here the antipodal cells are not absorbed during the formation of the endosperm, but persist throughout. They were in the perfectly normal condition even when the embryo had reached the size figured in fig. 26, and the endosperm had been somewhat absorbed. The end of the embryo-sac occupied by them remains narrow, but widens abruptly above them (fig. 18).

Here the behavior of the antipodal cells seems very peculiar. Just what they represent in the angiosperm embryo-sac is still a mystery, and it seems to me that at present the facts are insufficient to justify speculation. We must wait, at least, until the development of the embryo-sac is known in the lowest forms of the angiosperms.

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EXPLANATION OF PLATES XXVII–XXIX.

Figs. 8, 9, 10, 11, 12, 20, ×560 diam. Figs. 13, 18, ×280 diam.; all the rest ×405 diam.—Fig. 1. Embryo-sac just before the formation of the endosperm

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[3] Zellbildung und Zelltheilung, dritte Auflage, 1889, p. 11.

[4] Strasburger: Ueber Befruchtung und Zelltheilung, 1878, p. 71.

nucleus.—Figs. 2, 3. Embryo-sacs just before the flower opens, measuring .152^{mm} in length.—Fig. 4. Antipodal cells divided, the two upper by oblique walls.—Fig. 5. Elongated nucleus of the lower antipodal cell.—Fig. 6. Peculiar condition of antipodal cells; the wall x well developed; x', x', very delicate.—Fig. 7. Embryo-sac at the time of fertilization, .216^{mm} long by .048^{mm} wide.—Figs. 8, 11. Upper part of embryo-sac showing egg-apparatus, endosperm nucleus and pollen tube.—Fig. 12. Fertilized egg; synergidae disappearing.—Fig. 13. Embryo-sac with two-celled embryo.—Fig. 18. Embryo further developed, surrounded by endosperm tissue. Figs.—14, 17. Embryos in different stages of development; 1—1 primary transverse wall.—Figs. 19–20. Transverse section of upper end of young embryo; in 19a and 20 the four cells forming the inner circle are the plerome; the next outer row the periblem; and in 20 the outermost row the dermatogen.—Figs. 21–26, longitudinal sections of older stages of the embryo; in figs. 25 and 26 the heavier lines indicate the boundary between plerome and periblem.—Fig. 27, two endosperm cells.

Descriptions of new species of Uredineæ and Ustilagineæ, with remarks on some other species. I.

P. DIETEL.

The following described species of fungi, principally Uredineæ, have been collected by Mr. E. W. D. Holway and some other collectors in California and several other portions of the United States. Three other new species, namely, *Uromyces aureus* Diet. and Holw., *Puccinia Holwayi* Diet., and *Puccinia Delphinii* Diet. and Holw., have already been published in Hedwigia, XXXII (1893). 29, 30.

Ustilago Holwayi Diet. n. sp.—Spore masses black-brown, pulverulent, destroying the whole inflorescence. Spores subglobose or obovate, brown, with large warts, 8–13μ in diameter.

On *Hordeum pratense*. Camp Badger, Calif., July, 1892, leg. *Holway.*

From the similar *Ustilago Lorentziana* Thüm. (Mycotheca univ. no. 1711) this differs, as an examination has shown, by the shape of the epispore.

Puccinia rufescens Diet. and Holw. n. sp.—Spots none. Æcidia forming loose and irregular groups, or isolated on both sides of the leaves. Pseudoperidia hemispherical, with decaying edges, composed of oblong, loosely aggregated cells. Æcidiospores mostly ovoid or obovate, with a light brownish membrane, containing orange red protoplasmic contents,

minutely verrucose, 18–25×17–20μ. Teleutospores: sori amphigenous, mostly around the aecidial groups, reddish brown, pulverulent, first covered by the elevated epidermis, soon naked, irregular in form and size, measuring from 1–6^{mm}. Spores rounded at the apex and base, distinctly constricted at the septum, with a tuberculated epispore, apical thickening little or none, 32–46×21–31μ. Pedicels hyaline, very deciduous, as long as the spores. Unicellular spores are of frequent occurrence.

On leaves and bracts of *Pedicularis semibarbata.* Kings River Cañon, Calif., July 15, 1892, leg. *Holway.*

This is the third Puccinia known at the present time on Pedicularis. The other two are *Puccinia Clintoni* Peck on *Pedicularis Canadensis* in America, and *Puccinia Pedicularis* Thüm. on *Pedicularis Œderi* in Asia. The American species differs in having a smooth epispore with a papilla at the apex, the Asiatic by the form of the teleutospores. In neither have æcidia been observed.

Puccinia intermedia Diet. and Holw. n. sp.—Spots none; sori amphigenous, circular, 0.33–0.75^{mm} in diameter, scattered, sometimes confluent, dark brown, containing uredo- and teleutospores. Uredospores broadly ovate or subglobose, finely echinulate, brown, 21–23×17–23μ. Teleutospores oblong, mostly rounded on both sides, sometimes protracted in a hyaline papilla at the apex, distinctly constricted at the septum, verrucose, brown, apical thickening not very considerable, often nearly wanting, 32–40×17–23μ. Pedicels deciduous.

On *Epilobium* sp. Kings River Cañon, Calif., July, 1892, leg. *Holway.*

Puccinia intermedia is in some respects intermediate between *Puccinia pulverulenta* Grev. and *Puccinia Epilobii* DC. From P. Epilobii it differs in the manner of attacking the host plant, in possessing a uredosporic fructification and having the spores much less constricted; P. pulverulenta differs by the smooth epispore and other properties of the teleutospores.

Puccinia Californica Diet. and Holw. n. sp.—Sori amphigenous, scattered, without discoloration of the nourishing plant, almost concealed by the pubescence of the host plant, if occurring on the under side of the leaves; roundish or oblong, ca. 1^{mm} in diameter. Uredospores very uniform, globose or shortly elliptical, dark brown, very thickly but finely

echinulate, $26-31 \times 26\mu$. Teleutospores forming black sori; spores rounded on both sides or somewhat attenuated below, slightly constricted, chestnut brown, thickened very slightly, if at all, around the apical germ-pore, tuberculated, $42-52 \times 26-36\mu$. Pedicels long (up to 125μ), colorless, rather deciduous. Amongst the bicellular teleutospores occur often unicellular ones.

On *Cnicus Breweri.* Kings River Cañon, Calif., July 14, 1892, leg. *Holway.*

From all similar species on Compositæ known to the writer this Puccinia is easy to be distinguished by the darker colored and much more densely echinulate epispore of the uredoform. In the form and size of the teleutospores it has most resemblance to the European *Puccinia Cirsii lanceolati* Schröt.

Puccinia Cymopteri Diet. and Holw. n. sp.—Attacking all parts of the host plant. Sori black-brown, very pulverulent, soon naked, at first covered by the grayish epidermis. Teleutospores ovate or oblong, sometimes irregular, rounded on both sides, hardly constricted in the middle, slightly verrucose, deep brown, $33-45 \times 20-27\mu$. Pedicels short, deciduous.

On *Cymopterus terebinthinus.* Kings River Cañon, Calif., July, 1892, leg. *Holway.*

This species is distinctly different from *Puccinia Jonesii* Peck, which in Dr. Farlow's Provisional Host-Index is said to occur on *Cymopterus bipinnatus.*

Puccinia Polemonii Diet. and Holw. n. sp.—Amphigenous, sori roundish, scattered, $0.5-2.5^{mm}$ in diameter. Two kinds of teleutospores are formed; the ones, principally in the centre of the sori, with a colorless or nearly colorless membrane thickened at the apex and with firm long pedicels, germinating directly, are fusiform and little constricted at the septum before germinating; the others, with deciduous pedicels, germinating, as it seems, only after a period of rest, are yellowish brown in color, obovate or fusiform, distinctly constricted and surmounted with a conical, hyaline papilla. Epispore smooth, $29-45 \times 12-17\mu$. On an average the colored spores are broader than the colorless ones.

On leaves of *Polemonium cœruleum.* Kootenai County, Idaho, July, 1892, leg. *J. H. Sandberg.*

PUCCINIA CLARKIÆ Peck.—Of this species, not recorded by De Toni in Saccardo's Sylloge Fungorum, hitherto only

teleutospores have been described. Mr. Holway has collected beautiful specimens of this fungus on *Clarkia elegans* in California (Camp Badger) with uredo- and teleutospores and has sent me, too, a specimen on *Clarkia pulchella* with uredospores from Idaho, collected by Mr. Geo. B. Aiton. From these the following description is taken. Sori hypophyllous, the teleutospore layers often arranged into circles, rather long, covered by the elevated epidermis. Uredospores broadly ovate or nearly spherical, brown, echinulate, $22–29 \times 18.5–25 \mu$. Teleutospores oblong, upper cell rounded or obconical, sometimes with a distinct papilla, thickened at the apex in different degrees, lower cell rounded or somewhat attenuated below, central constriction little, epispore smooth, chestnut brown, $37–50 \times 20–25 \mu$. Pedicels firm, long.

UROMYCES BOREALIS Peck on *Hedysarum boreale* and *Hed. Mackenzii* agrees in all respects with the European *Uromyces Hedysari obscuri* (DC.).

Uredo *(Melampsora?)* **Arbuti** Diet. and Holw. n. sp.—Hypophyllous, sori densely aggregated into irregular groups, or scattered over the greater part of the leaf, not confluent, hemispherical before the epidermis is ruptured, minute, ca. 0.2^{mm} in diameter. Spores pyriform or club-shaped, colorless, filled with orange red granular protoplasm, echinulate, $28–55 \times 15–22 \mu$.

On *Arbutus Menziesii.* Mt. Tamalpais, Calif., April 1, 1893, leg. *W. C. Blasdale.*

Judging from the size of the spores and the general appearance, this Uredo belongs to a Melampsora.

On *Valerianella congesta* Mr. W. C. Blasdale has collected an æcidium in California (Mill Valley), which is probably the *Æcidium Valerianellæ* Biv. Bernh. The pseudoperidia are scattered over the whole underside of the leaves. The spores, appearing, if examined dry, very minutely verrucose, are subglobose or ovate and measure $17–27 \times 15–20 \mu$.

Leipzig, Germany.

Contribution to the biology of the organism causing leguminous tubercles.

GEO. F. ATKINSON.

WITH PLATES XII–XV.

(Concluded from p. 237.)

Comparative review.

This brings the history of the more important contributions to the biology of the leguminous tubercle organism, that have come to the notice of the present writer, down to the present time. The record presents a discouraging volume of conflicting testimony, some of it from eminent investigators. It would indeed be a misfortune should all these painstaking and laborious investigations really be so much at variance as appears from this examination of the contributions. Some of them which deny any external agent of a microbic nature will always remain important expositions of the structure and development of the tubercles. Had more attention been given by these investigators to careful cultural experiments perhaps they might have come to different conclusions. The charge might perhaps be made that cultural experiments are untrustworthy since Tschirch[97] and Frank[98] assert that sterilizing the soil by heat so changes its physical condition as to interfere with the development of the tubercles. Frank[99] and Schindler[100] also believe that the formation of the tubercles stood in direct relation to the vigor or assimilatory activity of the plants. Since plants do not usually grow so well under cultural conditions this might be said to argue against the trustworthiness of cultural experiments. In a large series of cultural experiments designed especially to test the correctness of these suggestions Prazmowski found them to be groundless. The cultural experiments carried on by the present writer show that sterilizing the soil, or a low state of vigor in the plants, will not prevent the development of the tubercles if the proper organism is given access to the roots.

In view of all the cultural experiments referred to above,

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[97] Bot. Centralb. XXXI (1887).

[98] Ueber den Einfluss, welchen das Sterilisieren des Erdbodens auf die Pflanzenentwickelung ausübt. Ber. d. deutsch. bot. Gesells. VI (1888). *XCV.*

[99] Untersuchungen über die Ernährung der Pflanze mit Stickstoff. Landw. Jahrb. XVIII (1888). 496.

[100] Jour. für Landwirtschaft. XXXIII (1885). 330.

and in addition those carried on by Atwater,[101] Bréal,[102] Bertholet,[103] and Vines,[104] conviction becomes inevitable that leguminous plants can only develop tubercles when excited by the presence of certain micro-organisms.

The important question then is, can these various conflicting notions of the biology of the microsymbiont be harmonized? Leaving out of consideration for the present the real nature of the organism it will be admitted by those who take the trouble to familiarize themselves with the scope of the work covered by the most important investigations that the organism in question consists of an elongated thread-like structure, which branches freely within the tubercle and possesses enlarged portions which present a more or less finely lobed surface; and very much smaller forms which must exist to some extent within the tubercle, are capable of multiplying in artificial media, and, when transplanted from artificial media to the roots of leguminous plants, are capable, under these more natural conditions and the stimulus of the macrosymbiont, of growing out again into the thread-like structures.

Beyerinck[105] then probably overlooked the real nature of the thread-like structures. From a careful study of his illustrations and descriptions it seems reasonably certain that, in some instances at least, he was dealing with the true organism in his artificial cultures. An examination of his figure II *C* shows the organism to be very similar in form to those in my own cultures represented in figures 11 and 12, plate XIV, and to those obtained by Laurent. In describing them he says: "Die Colonien auf Gelatine bestehen aus stark gebuckelten bacteroidenähnlichen Stäbchen." The culture of this one was obtained from tubercles of *Vicia hirsuta.*

Recently Nobbe, Schmid, Hiltner and Hotter,[106] while considering the organisms to be bacteria, admit that in the

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[101] Atmospheric nitrogen as plant food. Bull. no. 5, Storrs' School Agr. Exp. Station, Conn. Oct. 1889.

[102] Fixation de l'azote par les légumineuses. Compt. Rend. herbd. d. Sci. d. l'Acad. d. Sciences, Paris. CIX. Oct. 28. 1889.

[103] Experiénces nouvelles sur la fixation de l'azote par certain terres végétales et par certaines plantes. Ann. d. Chim. et d. Phys. VI. XVI. Avril, 1889.

[104] On the relation between the formation of tubercles on the roots of Leguminoseæ and the presence of nitrogen in the soil. Ann. Botany II (1888–1889). 386–388.

[105] Bot. Zeit. 1888.

[106] Versuche über die Stickstoff-Assimilation der Leguminosen. Landw Versuchs-Stationen. XXXIX (1891).

cultures, especially from tubercles of *Lupinus*, numerous larger bacteroid forms developed. "Wir haben jedoch in unseren mehrfachen Uebertragungen Gebilde oft in grosser Anzahl gefunden, welche unzweifelhaft als echte Bakteroiden angesprochen werden mussten."

The tests imposed by Eriksson,[107] Ward,[108] Vuillemin,[109] Pichi,[110] A. Koch,[111] and Laurent[112] for the determination of the presence of a membrane in connection with the thread-like structures, would seem to impeach Prazmowski's[113] and Frank's[114] explanations of its nature. H. Möller[115] also finds a membrane on the strands but interprets it as being a cellulose membrane deposited by the protoplasm of the leguminous plant around the bacterian zooglœa, and cites in support of this view cellulose membranes said by R. Wolff[116] to be deposited about the threads of *Ustilagineæ* by their hosts. Such a view does not seem to be any greater proof of the bacterian nature of the organism of the tubercles than of a like nature for the *Ustilagineæ*.

It is difficult also to harmonize Prazmowski's description of the organism in artificial cultures with that obtained by the majority of those who have succeeded in growing it outside of the tubercles. It would, perhaps, be unjust to infer that his cultures were contaminated; or shall we suspect him of committing the same error which he imputed to Beyerinck, *viz.*, that he was deceived in the appearance of the forked or lobed condition of the organism? Prazmowski says this appearance might be produced by one rod lying partly over another, since frequently he was for a time deceived by such appearances. Could we not then, on the same ground say that the bacteroids are not forked?

It was impossible in the case of the cultures obtained by the present writer to be deceived in the form of the organism. The rod-like forms were exceedingly rare. It would seem that Laurent's work was carefully guarded for Metchnikoff

[107] Bot. Zeit. 1874.
[108] Phil. Trans. Royal Soc. CLXXVIII; Proceed. Roy. Soc. XLVI.
[109] Ann. d. Sci. Agr. Franç. et etrang. 1888.
[110] Atti d. Soc. Toscani d. Sci. nat. 1888.
[111] Zur Kenntniss der Fäden in den Wurzelknöllchen. Bot. Zeit. 1890.
[112] Ann. d. l'Inst. Pasteur. V (1891).
[113] Landw. Versuchs-Stationen XXXVII (1890).
[114] Ueber die Pilzsymbiose der Leguminosen. Berlin, 1890.
[115] Ber. d. deutsch. bot. Gesells. X (1892). 242–249.
[116] Brand d. Getreides, 1874.

himself observed some of the lobed organisms in his cultures.

There does not seem to be any very important difference between the organisms described by Laurent and that obtained by myself. The result is the more satisfactory since the present writer did not know, at the time the organism was separated and first studied, what the real nature of Laurent's organism was. The account of the organism given by Ward agrees in all essential features with the one obtained by Laurent and myself.

Frank's mycoplasm of the tubercles is identical with the hyphæ, of course, but the reconciliation of his *Rhizobium*, a micrococcoid organism, with the forms obtained in culture by Beyerinck, Laurent and myself is not so easily effected, though the great majority of the individuals in the cultures from the tubercles of *Vicia sativa* were very small and without very high magnifying power would appear micrococcoid. The study of the form of the organism in the cultures was made with the aid of a Winkel microscope, the $\frac{1}{24}$ homogeneous immersion lens being used. A Zeiss 2^{mm} homogeneous immersion lens also served very well to bring out the definition of the form. Better results were obtained in examining the organism in a living condition, or by staining in a living condition with eosin. Killing and fixing the organism by heat on the cover glass did not give such good results because of the lack of firmness in the body of the organism.

Another question which arises, and which, if answered in the affirmative, may help to explain some of the discrepancies between the organisms in cultures by different investigators, is this: are there species or races of the microsymbiont? The bacteroids, by those who believe in the presence of a microsymbiont, are generally accepted as one form of the organism. They are regarded by Prazmowski as involution forms, because of their departure from the normal forms of rod-like bacteria. Whether or not we term them forms of involution it seems pretty certain that, when the organism has reached the firmness exhibited by the great mass of bacteroids in the tubercles, they are no longer capable of growth, since they have lost that power in becoming receptacles for the storage of proteid substance.

Prazmowski says the death of the bacteria is first announced in most cases by a change to the branched form. It would

probably be more nearly correct to say that the death of the organism, in its passage to the sterile condition of the perfect bacteroids is first indicated by a firmer condition of the organism, probably brought about by the increasing presence of proteid matter which in many cases finally becomes centered in different parts of the bacteroids and forms bodies which possess a very high power of refracting light. Lundström[117] described these in the tubercles of *Trifolium repens.* In some cases these bodies occupy nearly the entire inner portion of the bacteroids and frequently the accumulation takes place to such an extent as to cause the form of the bacteroid to enlarge, when, if there are several such bodies in an elongated bacteroid it presents a nodulose appearance as shown in some of the bacteroids from *Medicago denticulata* in figures 14 and 15 of plate XIV. In the bacteroids of species of Trifolium frequently the great increase in the size of these bodies gives to them the form of a bladder, and Beyerinck[118] has designated them as "Bläschenbacteroiden." Prazmowski shows that these bodies in the bacteroids do not take such stains as methyl violet. The present writer has observed that they do not take the stains gentian violet and fuchsin. On staining bacteroids from tubercles of *Medicago denticulata* with fuchsin they present an interrupted stain, simulating in this respect the rods of *Bacillus tuberculosus.* It is quite likely that the difficulty experienced in staining these objects in the tubercles has led some to describe the stained portions as spores.

Prazmowski calls attention to the fact that concentrated sulphuric acid will not dissolve normal bacteria, but that it will dissolve these highly refringent bodies in the tubercles giving to them a rose red color, which he claims shows them to be proteid bodies. Recently Frank[119] places them with the starch group calling them amylodextrin bodies while H. Möller,[120] in reply says they represent some form of cholesterin. In this same paper Frank states that he has discovered a dimorphism in the tubercles on the roots of peas, that the large profusely forked ones bear principally these

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[117] Bot. Centralb., XXXIII (1888).

[118] Bot. Zeit. 1888.

[119] Ueber den Dimorphismus der Wurzelknöllchen der Erbse. Berichte d. deutsch. bot. Gesellsch. x (1892). 170–178.

[120] Bemerkungen zu Frank's Mittheilung über den Dimorphismus der Wurzelknöllchen der Erbse. Ber. d. deut. bot. Ges. x (1892). 242, 249.

amylodextrin bacteroids, while the smaller simple forms bear principally proteid bacteroids. H. Möller takes exception to this statement also, while Frank[121] refutes Möller's objection on the ground that Möller's study was confined to the tubercles of *Trifolium*, while Frank's announcement of a dimorphism related to the tubercles on *Pisum*.

There are many different forms of bacteroids associated with the tubercles of different species or genera of leguminous plants. As noted above Schneider has based several species of his *Rhizobium* purely on these characters of form and the more or less definite localization of the protoplasm at various points of the accumulation of these highly refringent and not readily stained bodies.

Morck,[122] while not describing them as species, figured numerous forms from tubercles of between forty and fifty species of *Leguminosæ*.

While these bacteroids are incapable of growth they may represent to a certain extent morphological characters of the organism within the tubercles. If this be true it would strengthen the proposition suggested by different forms obtained in artificial cultures that there are different varieties, or races, of the organism.

Schrœter[123] describes two species of his *Phytomyxa* based on the presence or absence of the strands in the tubercles. Some investigations of Hellriegel, Laws and Gilbert, Prazmowski (l. c.), point to a probability that lupines will not develop tubercles when seeded with soil-extract from places where lupines have not grown, while peas, etc., seeded with the same soil-extract develop the tubercles.

Beyerinck (l. c.) claims that in his artificial cultures different races were obtained which remained true to form through successive cultures.

Nobbe, Schmid, Hiltner and Hotter[124] found that *Lupinus luteus* inoculated with pea tubercle organisms, as well as those from *Robinia*, *Cytisus* and *Gleditschia*, developed no tubercles, but when inoculated with lupine tubercle organisms, devel-

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[121] Ueber Möller's Bemerkungen bezüglich der dimorphen Wurzelknollchen der Erbse. Ber. deutsch. bot. Gesells. x (1892). 390–395.

[122] Ueber die Formen der Bakteroiden bei den einzelnen Spezies der Leguminosen. Inaug-Dissert. Leipzig, 1891.

[123] Kryptogamen-Flora von Schlesien, 134.

[124] Versuche über die Stickstoff-Assimilation der Leguminosen. Landw. Versuchs-Stationen xxxix (1891). 227–359.

oped tubercles. *Phaseolus vulgaris* inoculated with cultures from tubercles of *Phaseolus* and peas developed tubercles, but if inoculated with cultures from tubercles of *Lupinus* or *Robinia*, none were developed. In one case *Pisum sativum* inoculated with lupine tubercle organisms developed tubercles, while in other cases it did not. In the case where the tubercles were developed, the hyphæ and bacteroid characteristic of those of the peas under normal conditions were developed. If this development of tubercles on peas from lupine organisms were not an accidental contamination it would indicate that one and the same species occurred in the tubercles of peas and lupine. Other cross inoculations made by them occasionally took effect but there was shown a disposition to tardy and weak development as if the organism had been in some unsuitable condition.

At the same time that the present writer carried on the second experiment in the inoculations of *Vicia sativa* with artificial cultures of the vetch tubercle organism, inoculations were also made of young plants of *Dolichos sinensis* with organisms from the same culture but no tubercles were developed while the inoculated plants of *Vicia sativa* developed tubercles.

But considering the almost universal infection of leguminous plants when grown in a state of nature it is difficult to believe that there are so many species as are represented by the different forms of bacteroids. Rather at the present time the question might be asked, does not the influence of the macrosymbiont upon the microsymbiont while within the tubercle fix a certain type of racial form and attenuation upon the microsymbiont until it shall have passed through normal conditions in the soil again and been restored to its original form and infecting power? The system of preventive inoculation depends largely upon the development of racial peculiarities and degrees of attenuation obtained by growing organisms in the presence of some deleterious substance, by cultivating them at certain temperatures for given periods of time, subjecting them to various degrees of atmospheric pressure, as by passing them through the bodies of other animals than those in which the organism is at first so virulent. While it is maintained by some that these racial peculiarities artificially produced remain fixed, there is evidence to show that after a time the attenuated organism may, by being subject

to certain normal influences, gradually regain its pristine characteristics and virulence.

This suggestion is only offered as a possible hypothesis for the explanation of apparent racial peculiarities in the microsymbionts of the tubercles. It must stand or fall only by a very comprehensive and thoroughgoing investigation. If it should be proven to be a correct one it would help to explain some of the conflicting observations upon the morphology of the organism.

Its solution one way or the other must be the crowning result of the remarkable series of investigations that have thus far contributed to a knowledge of one of the most abstruse problems of biological science, and would give a firm foundation for the most rational treatment of the economic phases of the subject.

Synonymy.

The question of generic synonymy and classification also deserves consideration. *Protomyces* and *Schinzia* to which the organism was referred at successive times by Frank can not stand because the fungi first associated with these genera would have precedence over the present one. *Bacillus*, to which Beyerinck referred it, can not be retained, since, as Prazmowski has shown, we do not at present know of an endogenous spore formation, and also for the reason that, even according to Beyerinck, the organism is not a true schizomycete. The latter reason would disqualify *Bacterium*, the location proposed by Prazmowski. Frank's *Rhizobium* is based on a micrococcoid form which at least could only represent a minute form of the organism, leaving out of consideration entirely, as Frank does, the hypha form as a part of his *Rhizobium*.

Laurent is not justified then in emending by expansion a genus based on a micrococcoid form, to include a complex plant the important characters of which the author of *Rhizobium* says form no genetic connection with his genus. Likewise it can not be justly emended from either Frank's or Laurent's *Rhizobium* to embrace only the bacteroids of the tubercles as Schneider has done.

However, Schrœter's *Phytomyxa* antedates Frank's *Rhizobium*. It is, moreover, a very easy matter to determine the fungus from Schrœter's description of *Phytomyxa*, even though the author may have erred in placing the genus among

the *Myxomyceteæ*. In fact *Phytomyxa* was erected to represent exactly the morphological characters which we find present in the fungus in the tubercles.

Laurent, probably from the analogy of the form of some of the bacteroids and the forked individuals in his artificial cultures to the various stages of longitudinal division, as Metchnikoff[125] terms it, of *Pasteuria ramosa*, places it in the family *Pasteuriaceæ*. There does notseem to be any good evidence that longitudinal division occurs in the organism of the tubercles, as is described for *Pasteuria*, but that these forked forms are derived in an entirely opposite manner, from that which obtains in *Pasteuria*, *i. e.*, by growth instead of longitudinal division, or what seems, more properly speaking, from Metchnikoff's descriptions to be a stellate or radiate division, beginning with numerous invaginations upon the external surface and proceeding toward the center until finally the quadrants and octants present a division approaching the longitudinal.

It still remains to note certain remarkable phenomena observed by the present writer in one of the cell cultures of the vetch tubercle organism. The microscope was focussed upon several individuals representing various lobed forms to observe their development. Sketches were made of the position and form of all the individuals in the field of the microscope in order that their development might be accurately recorded. In the course of twenty-four hours one of the individuals had disappeared from view, and now and then minute motile organisms swept across the field. During that day one of the larger lobed forms disintegrated by the loss in some way, which was not observed because interrupted observations were made, of the dense portions of protoplasm at certain points near the periphery. The most remarkable phenomenon, however, was the fact that one of the individuals, the form of which might be described as representing the union of two clavate bodies by their larger ends, was moving about sluggishly as if drawn by something attached to one end. For ten to fifteen minutes it moved about within the field of the microscope with a slow oscillatory movement combined with the progressive movement, when it disappeared from view. These observations have suggested the possibility of the formation of zoospores within the larger of the individuals in artificial cultures and in the buddings or enlargements of the hyphæ within the tubercle.

[125]Ann. d. l'Institut Pasteur II (1888). 165–170.

Little value is attached by the writer to these observations since it was impossible at that time to repeat them, for in a few days his labors were to be removed from Alabama to New York, and during the move the infusion of *Vicia sativa* with which it was designed to make media to prosecute the study farther became contaminated. During the busy period of organizing work in a new field the organism died before fresh culture media could be made.

Laurent did not observe a motile stage. Beyerinck observed motile forms which agree in size with the smallest forms (0.2μ) obtained by myself. If Frank's micrococci and Prazmowski's swarmers could be regarded as the same forms represented by these small individuals the possibility of there being zoospores would be strengthened. Should the presence of zoospores be confirmed it would indicate a relationship to the lower *Phycomycetes*. It will be remembered that Vuillemin (l. c.) placed the organism in the *Chytridiaceæ*, but the zoospores of his *Cladochytrium tuberculorum* were 7μ in diameter, a size much greater than any except possibly some of the very largest of the organisms obtained by other investigators, and since his studies were made in late autumn on old tubercles there may have been some chance of monads occurring in the tissue of the tubercles.

While in some characters, as noted above, the tubercle organism is very much like *Cladochytrium tenue*, yet in the sum of essential characters it departs too widely from that genus, so that even if it should eventually be clearly shown to be one of the *Chytridiaceæ*, it would still be referable to *Phytomyxa*.

Cornell University.

Explanation of Plates XII–XV.

Plate XII.—Tubercles of Vicia sativa, from photographs.

Plate XIII.—Fig. 4. Young tubercle, magnified, showing affected root hair.—Fig. 5. Same root hair more magnified, showing form of infecting thread.—Fig. 6. Another view of fig. 5.—Fig. 7. Section of outer portion of tubercle with root hair, showing entering infecting thread.—Fig. 8. Section of young tubercle with infecting thread *in situ* showing enlargement and buds; *en*, endodermis; *pe*, pericambium; *ph*, phloem; *x*, xylem.

Plate XIV.—Fig. 9. Infecting thread drawn to larger scale.—Fig. 10. Portion of bacteroid tissue containing branching threads of *Phytomyxa*; *n*, nucleus of tubercle cells.—Figs. 11 and 12. Organisms in pure culture of *Phytomyxa* from vetch tubercle.—Fig. 13. Bacteroids of *Vicia sativa* tubercle.—Figs. 14 and 15. Bacteroids of *Medicago denticulata* tubercle. The scale in 13, 14 and 15 is $\frac{1}{2}^{mm}$, and the objects are magnified thirty times more than the scale.

Plate XV.—Inoculation. Water culture of *Vicia sativa*. Nos. 1 and 4 inoculated with organisms from pure culture of *Phytomyxa* from *Vicia sativa* tubercles. From photograph.

Flowers and insects. XI.

CHARLES ROBERTSON.

STELLARIA MEDIA Sm.[1]—"Nat. from Eu."—The plant was observed in bloom from March 14th to Oct. 25th. It is not abundantly visited except in early spring, when the flowers form quite conspicuous patches. At this time frequent cross-pollination is inevitable. On seven days, March 25th to April 29th, and Oct. 15th, I observed the following visitors, all sucking:—

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿; (2) Ceratina dupla Say ♂; (3) Osmia lignaria Say ♂; (4) Nomada bisignata Say ♂; (5) N. luteola Lep. ♂; *Andrenidæ:* (6) Panurgus? andrenoides Cr. ♂; (7) Andrena sayi Rob. ♂; (8) A. illinoensis Rob. ♀; (9) A. flavo-clypeata Sm. ♂; (10) A. cressonii Rob. ♂♀; (11) A. forbesii Rob. ♀; (12) Augochlora pura Say ♀, ab.; (13) Halictus lerouxii Lep. ♀; (14) H. ligatus Say ♀; (15) H. fasciatus Nyl. ♀; (16) H. pilosus Sm. ♀; (17) H. gracilis Rob. ♀; (18) H. confusus Sm. ♂♀; (19) H. stultus Cr. ♀; (20) Colletes inaequalis Say ♂; *Chalcididæ:* (21) Smicra torvina Cr.; *Ichneumonidæ:* (22) Pimpla novita Cr. (determined by Ashmead); *Tenthredinidæ:* (23) Dolerus arvensis Say.

Diptera—*Mycetophilidæ:* (24) Sciara sp.; *Syrphidæ:* (25) Chilosia capillata Lw.; (26) Melanostoma obscurum Say; (27) Platychirus quadratus Say; (28) Syrphus ribesii L.; (29) S. americanus Wd.; (30) Mesograpta marginata. Say; (31) Eristalis tenax L.; (32) E. aeneus F.; (33) E. dimidiatus Wd.; (34) Brachypalpus frontosus Lw.; (35) Syritta pipiens L.; *Tachinidæ:* (36) Gonia frontosa Say, ab.; (37) G. exul Will.; *Sarcophagidæ:* (38) Cynomyia sp.; *Muscidæ:* (39)

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[1]See Axell: Om anordningarna för de Fanerogama Växternas Befruktning; Lubbock: British Wild Flowers in Relation to Insects; Müller: Fertilization of Flowers, and Weit. Beobachtungen; Henslow: Self-fertilization of Plants; Anna Bateson: The Effects of Cross-fertilization on Inconspicuous Flowers, Annals of Botany, I; Meehan: Contributions to the Life Histories of Plants, III, Proc. Acad. Sci. Phila., 1888; Battandier: Sur quelques cas d'heteromorphisme, Bull. Soc. bot. France, XXX; Ludwig: Botan. Ver. d. Provinz Brandenburg, XXVI; MacLeod: Untersuchungen über die Befruchtung einiger phanerogamen Pflanzen d. Belgischen Flora, Bot. Centralblatt, XXIII; Schulz: Beiträge zur Kenntniss d. Bestäubungseinrichtungen u. Geschlechtsvertheilung bei den Pflanzen.

Pollenia rudis F.; (40) *Musca domestica* L.; (41, 42) Lucilia spp.; (43) L. cornicina F.; (44) Myospila meditabunda F.; *Anthomyidæ:* (45) Chortophila sp.; *Cordyluridæ:* (46) Scatophaga squalida Mg.

Lepidoptera—*Nymphalidæ:* (47) Pyrameis huntera F.; *Lycaenidæ:* (48) Lycaena pseudargiolus B.-L.

Hemiptera—*Lygaeidæ:* (49) Lygaeus turcicus F.

	Bees.	Other Hymenoptera	Diptera	Other insects.	Total.
In Low Germany—Müller....	15	1	8	1	25
In Illinois..................	20	3	23	3	49

MALVA ROTUNDIFOLIA L.[2]—"Nat. from Eu."—In the Fertilization of Flowers Müller says that the flowers of this species attract few insects, and he gives a list of visitors which compares very unfavorably with the list taken on flowers of *M. sylvestris.* In Illinois the plant seems to have little difficulty in acquiring a useful set of visitors. The subjoined list compares favorably with Müller's list of visitors of *M. sylvestris.* The plant blooms from April to November. On eleven days, between May 14th and October 9th, the following insects were observed visiting the flowers:—

Hymenoptera—*Apidae:* (1) Apis mellifica L. ☿, s., freq.; (2) Bombus pennsylvanicus DeG. ♀, s.; (3) Melissodes bimaculata Lep. ♂, s.; (4) Ceratina dupla Say ♀, s. and c. p.; (5) Nomada incerta Cr. ♀, s.; (6) Calliopsis andreniformis Sm. ♂♀, s. and c. p., ab.; *Andrenidae:* (7) Agapostemon bicolor Rob. ♂♀, s. and c. p.; (8) A. radiatus Say ♂, s., freq.; (9) Augochlora pura Say ♂♀, s.; (10) Halictus pectoralis Sm. ♂♀, s.; (11) H. similis Sm ♀, s. and c. p.; (12) H. coriaceus Sm. ♀, s.; (13) H. ligatus Say ♂♀, s.; (14) H. fasciatus Nyl. ♀, c. p., freq.; (15) H. pilosus Sm. ♀, s.; (16) H. zephyrus Sm. ♂, s., (17) H. confusus Sm. ♂♀, s., ab.; (18) H. illinoensis Rob. ♀, s.; (19) H. stultus Cr. ♂, s.; (20) Prosopis affinis Sm. ♀, f. p.

[2]See Sprengel: Das entdeckte Geheimniss; Lubbock: British Wild Flowers in relation to Insects; Henslow: On the Self-fertilization of Plants—Trans. Linn. Soc. II. 1; On the fertilization of flowers by bees and other insects—Journ. Roy. Hort. Soc. London, VI; Müller: Fertilization of Flowers, and Weit. Beobachtungen; MacLeod: Pyreneenbloemen en hare bevruchting door insecten; Keller: Proc. Acad. Nat. Sci. Phila., 1892, 452.

Diptera—*Syrphidae:* (21) Mesograpta marginata Say, s. and f. p.; *Muscidae:* (22) Lucilia cornicina F., s.; *Anthomyidae:* (23) Chortophila sp., s., freq.

Lepidoptera—*Rhopalocera:* (24) Pieris rapæ L., s.

Coleoptera—*Malachidae:* (25) Collops 4-maculatus F., f.p.

	Halictus.	Other bees.	Other insects.	Total.
In the Pyrenees—MacLeod	–	1	–	1
In Low Germany—Müller	2	3	1	6
In Illinois	13	7	5	25

SIDA SPINOSA L.—"Nat. from the tropics."—The stigmas receive pollen from the dehiscent anthers, but may be effectually dusted with pollen from other flowers in case of early insect visits. Later the styles bend and turn the stigmas in among the anthers, so that thorough self-pollination is insured. The plant has small yellow flowers. It was noted in bloom from July 25th to October 3d, and the following visitors were observed:—

Hymenoptera—*Apidæ:* (1) Bombus americanorum F. ♂☿, s.; (2) Ceratina dupla Say ♀, s. and c. p.; *Andrenidæ:* (3) Augochlora pura Say ♂, s.

Lepidoptera—*Papilionidæ:* (4) Pieris protodice B.-L.; (5) P. rapæ L.; (6) Colias philodice Gdt.; (7) Terias lisa B.-L.; *Hesperidæ:* (8) Pyrgus tassellata Scud.

ABUTILON AVICENNÆ Gærtn.—"Adv. from India."—The flowers are yellow and occupy very inconspicuous positions under the large leaves. They are spontaneously self-pollinated in absence of insects, but may be cross-pollinated in their presence. For a long time I thought that nectar was wanting and that visitors never occurred, but in three days, August 21st to September 19th, I captured the following insects on the flowers:—

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s.; (2) Bombus separatus Cr. ☿, s.; (3) B. americanorum F. ♂☿, s.; (4) Melissodes bimaculata Lep. ♀, s. and c. p.; *Andrenidæ:* (5) Halictus confusus Sm. ♀, c. p.; (6) H. fasciatus Nyl. ♀, s.; (7) H. coriaceus Sm. ♀, s.

Diptera—*Syrphidæ:* (8) Mesograpta marginata Say, f. p.; *Anthomyidæ:* (9) Chortophila sp., s.

Lepidoptera—*Papilionidæ:* (10) Pieris rapæ L.; *Hesperidæ:* (11) Pholisora catullus F.

HIBISCUS LASIOCARPUS Cav.—With the exception of a single specimen of *Hibiscus militaris*, this is the only indigenous species of Malvaceæ which I have found in my neighborhood, and, as might have been expected, is the only one in which spontaneous self-pollination is impossible. It grows in swamps. The stalks, several of which form a cluster, rise from one to two metres, each stalk exposing two or three large flowers at a time.

The flowers are white or rose-tinted, with a crimson centre. They measure from eight to ten centimetres in length, and expand from nine to eleven centimetres, or more. The lower petals are directed horizontally; the upper are bent strongly upward like a vexillum, so as to be nearly perpendicular to the lower. The column lies near the lower petals and for about three centimetres from its base is provided with free filaments, which project upwards and sideways. On account of the flower being in an incipient stage of irregularity, the column still retains some useless filaments on the lower side, whose anthers seldom touch the bees. The five large capitate stigmas, which form a circle from nine to thirteen millimetres across, are advanced one or two centimetres before the nearest anthers, so that there is no chance of spontaneous self-pollination.

When visiting the flower, bees land upon the base of the column. The latter is bent upwards in such a position that the bees touch the stigmas before they alight. After sucking, the bees crawl out over the filaments and upon the lower petals and leave the flower without again touching the stigmas.

After alighting upon the column, *Emphor bombiformis*, which is the characteristic visitor, turns to the right or left and thrusts its proboscis into one nectary after another until it reaches the narrow interval between the column and the lower petals. Then it often turns back and inserts its proboscis into the nectary on the other side. Commonly, however, it fails to squeeze under the column to visit the nectary which lies there, and it often neglects to turn back for the nectary on the other side, and so leaves the flower without extracting the sweets from all the nectaries. Seventy-six individuals which I watched at this work missed eighty-one

nectaries in seventy-six flowers. On the other hand, *Bombus americanorum*, which is larger, more time-saving and less familiar with the flower, more frequently neglects to visit the nectary under the column and seldom turns back, so that it misses the lower nectaries even more frequently. I saw fifty-six individuals of this species miss eighty-five nectaries in fifty-six flowers. Both species also often miss the lower nectaries because, after inserting their proboscides into the upper ones and finding them empty, they arrive at the erroneous conclusion that the lower ones are in the same condition.

In their economy, the flowers of this plant and the bee first mentioned, *Emphor bombiformis*, stand in a very close relation. With the exception of single individuals taken on flowers of *Cephalanthus occidentalis* and *Ipomœa pandurata*, I have never taken this bee on any other flower. On the *Hibiscus* I have never failed to find it in favorable weather, and I have found the males in the closed flowers in bad weather. No specimens have been observed by me except during the blooming time of the plant, from July 25th to Sept. 16th. The female is provided with a large loose scopa which seems to be specially fitted to retain the large pollen grains, and this is the only flower on which I have seen it collecting pollen. Accordingly, I think the bee depends exclusively upon Hibiscus pollen for food for its larvae. I have seen the female making excavations for her nest within a few yards of the plants.

The only other insect at all frequent on the flower is *Bombus americanorum* F. ♂ ♀ ☿. I have never found this bee half as abundant, and commonly absent altogether, while the *Emphor* was abundant. This bumble-bee never collects the pollen. In addition to these insects I have seen the flowers visited for honey only by *Melissodes bimaculata* Lep. ♂ ♀ and by single individuals of *Bombus separatus* Cr. ♀, *Entechnia taurea* Say ♂, *Megachile brevis* Say ♂, *Euphoria sepulchralis* F. and *Trochilus colubris* L.

HIBISCUS TRIONUM L.[8]—"Adv. from Eur."—The five capitate stigmas stand close together, and pollen only touches the edges next to the dehiscent anthers. Most of the stigmas are thus free from pollen and can be effectually cross-pollinated in case of insect visits. After the flowers close, the styles bend outward and downward forcing the stigmas

[8]See Sprengel: Das entdeckte Geheimniss.

among the anthers so as to cover them with pollen. Thorough self-pollination is, therefore, only effected by a special movement of the stigmas, and only occurs after the flower has been exposed to insects. I have seen it visited only by a single individual of *Pieris rapæ* L.

GERANIUM CAROLINIANUM L.—The plant is common, blooming from May 23d to July 13th. The stem rises from 2 to 4^{dm}, is diffusely branched and bears numerous pale rose-colored flowers, which are not crowded so as to form an attractive combination.

The corolla is small, measuring about 7^{mm} across. In forms observed by me there are ten perfect stamens. The flowers are imperfectly proterandrous. The anthers of the inner circle are so closely approximated to the stigmas, that in absence of insects, spontaneous self-pollination may readily occur.

The flowers are adapted to small bees. June 10th I observed the following visitors:

Hymenoptera—*Apidæ:* (1) Alcidamea producta Cr. ♂♀, s., freq.; (2) Osmia conjuncta Cr. (=4-dentata Cr. ♂) ♀, s.; (3) Calliopsis parvus Rob. ♀, s. and c. p.; *Andrenidæ:* (4) Agapostemon radiatus Say ♀, s.; (5) Augochlora pura Say ♀, s. and c. p., freq.; (6) Halictus pectoralis Sm. ♀, s. and c. p., freq.; (7) H. tegularis Rob. ♀, s. and c. p.; (8) H. stultus Cr. ♀, c. p.; (9) Prosopis affinis Sm. ♀, s., freq.; *Eumenidæ:* (10) Odynerus sp., s., freq.

Diptera—*Syrphidæ:* (11) Mesograpta marginata Say, s., freq.; *Tachinidæ:* (12) Hyalomyia purpurascens Twns. s., one.

OXALIS VIOLACEA L.[4]—The scapes rise one decimetre, or more, high and expose an umbel of rose-purple flowers. The five petals expand 20^{mm}. At base they are approximated into a tube about 5^{mm} long, very wide in the throat, but obstructed by the ten stamens and five styles. The tube within is whitish, with greenish streaks proceeding from a greenish base. The calyx is about 4^{mm} long and is erect, aiding in giving firmness to the tube. In the long-styled form, spontaneous self-pollination is impossible, but in the short-styled form it may occur by the pollen falling upon the stigmas.

The plant is common and blooms from April 6th to June 10th. It is very abundantly visited by bees, mostly species

[4]See Trelease: The Heterogony of Oxalis violacea. Am. Nat. xvi; North American Geraniaceæ, Mem. Bost. Soc. Nat. Hist. iv; Trans. St. L. Acad. Science, v; Bot. Gaz. xii; Christy: Journ. of Bot. xxiii.

of small size. On eight days, between May 1st and 17th, I observed the following visitors:—

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s.; (2) Bombus americanorum F. ♀, s.; (3) B. pennsylvanicus DeG. ♀, s.; (4) Synhalonia speciosa Cr. (=Melissodes dilecta Cr. ♂) ♂ ♀, s., freq.; (5) Ceratina tejonensis Cr. ♂, s., (6) C. dupla Say ♂ ♀, s., freq.; (7) Osmia cognata Cr. ♂, s.; (8) O. albiventris Cr. ♀, s. freq.; (9) Nomada superba Cr. ♀, s.; (10) N. annulata Sm. (=articulata Cr. nec Sm.) ♂, s.; (11) N. sayi Rob. ♂ ♀, s., freq.; (12) N. cressonii Rob. ♂; *Andrenidæ:* (13) Andrena violæ Rob. ♀, s.; (14) A. ziziæ Rob. ♂♀, s.; (15) Agapostemon bicolor Rob. ♀, s.; (16) A. radiatus Say ♀, s.; (17) Augochlora pura Say ♀, s., ab.; (18) Halictus pectoralis Sm. ♀, s.; (19) H. forbesii Rob. ♀, s.; (20) H. lerouxii Lep. ♀, s. and c. p., ab.; (21) H. ligatus Say ♀, s. and c. p.; (22) H. fasciatus Nyl. ♀, s. and c. p., ab.; (23) H. pilosus Sm. ♀, s. and c. p., ab.; (24) H. confusus Sm. ♀, s.; (25) H. albipennis Rob. ♀, s.

Lepidoptera—*Rhopalocera:* (26) Phyciodes tharos Dru.; (27) Colias philodice Gdt., (28) Nisoniades brizo B.-L.

MELILOTUS ALBA Lam.—"Adv. from Eur."—The plant is common along side-walks. The stems rise from 6 to 12^{dm}, or more, in height and bear a profusion of spikes crowded with white blossoms. The flower measures about 4^{mm} in length to the tip of the keel. The calyx tube measures about 1^{mm} in depth, so that the nectar is easily accessible to short-tongued insects. The flower agrees in all essentials, except color, with that of *M. officinalis*, as described and figured by Müller in Fertilization of Flowers, 180. Müller saw *M. alba* visited by *Apis mellifica* L. ☿, *Macropis labiata* Pz. and *Empis livida* L.

The following were observed on June 23d and 25th:—

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s., ab.; (2) Bombus separatus Cr. ☿, s.; (3) Ceratina dupla Say ♀, s. and c. p.; (4) Megachile brevis Say ♀, s. and c. p.; (5) Alcidamea producta Cr. ♀, s. and c. p.; (6) Coelioxys 8-dentata Say ♂♀, freq.; (7) Epeolus fumipennis Say ♂, s., freq.; (8) Nomada incerta Cr. ♀, s.; (9) Calliopsis andreniformis Sm. ♂♀, s. and c. p.; *Andrenidæ:* (10) Macropis steironematis Rob. ♂♀, s. freq.; (11) Augochlora similis Rob. ♂, s.; (12) Halictus arcuatus Rob. ♀, s. and c. p.; (13) H. parallelus Say ♀, s.; (14) H. lerouxii Lep. ♂♀, s. and c. p.; (15) H. ligatus Say ♀, s. and c. p.; (16) H. fasciatus Nyl. ♀, s.;

(17) H. albipennis Rob. ♀, s. and c. p.; (18) H. confusus Sm. ♂♀, s. and c. p., ab.; (19) H. pruinosus Rob. ♂, s.; (20) Sphecodes arvensis Pttn. ♂, s.; (21) Colletes eulophi Rob. ♂♀, s.; (22) C. willistonii Rob. ♀, s.; *Vespidæ:* (23) Polistes pallipes Lep., s.; *Eumenidæ:* (24–26) Odynerus spp.; (27) Odynerus fulvipes Sauss.; (28) O. arvensis Sauss.; (29) O. foraminatus Sauss., freq.; (30) O. megæra Lep.; *Crabronidæ:* (31) Crabro interruptus Lep., freq.; (32) Oxybelus emarginatus Say; *Philanthidæ:* (33) Cerceris clypeata Dlb.; *Sphecidæ:* (34) Ammophila gryphus Sm.; (35) A. vulgaris Cr.; (36) A. pictipennis Walsh.; (37) A. intercepta Lep.; (38) Isodontia philadelphica Lep.; (39) Sphex ichneumonea L.; (40) S. pennsylvanica L.; (41) Priononyx atrata Lep.; *Pompilidæ:* (42) Pompilus sp.; (43) P. relativus Fox; (44) P. navus Cr.

Diptera—*Empidæ:* (45) Empis sp.; *Conopidæ:* (46) Oncomyia loraria Lw.; (47) Conops brachyrrhynchus Mcq.; *Syrphidæ:* (48) Platychirus quadratus Say; (49) Syrphus americanus Wd.; (50) Allograpta obliqua Say; (51) Sphaerophoria cylindrica Say; (52) Syritta pipiens L.; *Tachinidæ:*[6] (53) Cistogaster occidua Wlk.; (54) Ocyptera euchenor Wlk. freq.; (55) Jurinia apicifera Wlk.; (56) J. smaragdina Mcq.; (57) Cuphocera ruficauda v. d. W.; (58) Micropalpus fulgens Mg., ab.; (59) Phorocera edwardsii Will.; (60) Acroglossa hesperidarum Will., ab.; (61) Trichophora echinomoides Twns., ab.; (62) Oliviera americana Twns.; (63) Pseudomyothyria nigricornis Twns.; *Sarcophagidæ:* (64–65) Sarcophaga spp.; *Muscidæ:* (66) Cyrtoneura sp.; (67) Lucilia caesar L.; (68) L. cornicina F. —all s.

Lepidoptera—*Rhopalocera:* (69) Chrysophanus thoe B.-L.; (70) Thecla humuli Harr.; *Sesiidæ:* (71) Sesia sexfasciata Hy. Edw.

Coleoptera—*Scarabaeidæ:* (72) Trichius piger F., s.; *Cerambycidae:* (73) Typocerus sinuatus Newm., s.; *Mordellidæ:* (74) Mordella marginata Melsh., s.; *Curculionidæ:* (75) Centrinus sp.; (76) C. picumnus Hbst.; (77) C. scutellum-album Say, freq.

Hemiptera—*Lygaeidæ:* (78) Lygaeus turcicus F., s.; *Pentatomidæ:* (79) Podisus spinosus Dal., s., one.

Carlinville, Ills.

[6]The Tachinidæ mentioned in this paper were determined by Mr. C. H. Tyler Townsend.

BRIEFER ARTICLES.

Difference between the common salt-wort and the Russian thistle.—Farmers' Bulletin no. 10, of the Department of Agriculture, on the Russian thistle and other weeds, has aroused some interest in the distinctive differences between the harmless saltwort *Salsola Kali* L. and the noxious Russian thistle *Salsola Kali* L., var. *tragus* DC. The former has existed on the Atlantic coast for nearly a century at least and appears to be indigenous there and also in saline localities in the Black Hills. It has never been regarded as a troublesome weed. The variety *tragus* was introduced into South Dakota from Russia about seventeen years ago and is now justly regarded as the worst weed in the northwest.

The two forms appear very much alike but it is a matter of importance that they should be distinguished.

The original description of the variety is as follows: "*β Tragus*, suberecta glabra viridis, alis subbrevibus subroseis vel roseis."—DC. Prod. XIII. *2*. 187. It is given here in full because De Candolle's Prodromus is not as available to all botanists as one might wish. In addition to these characters the following may aid in distinguishing the variety from the species: The species *S. Kali* does not become bright red or magenta colored at maturity. The middle bract, or a bract-like leaf subtending the floral bracts, is usually much longer than the others. The calyx is dull white or slightly rose-colored and coriaceous; the wing on the back of the calyx lobes is thick and comparatively narrow, less prominent than the ascending lobe.

The variety *tragus* becomes rose-colored or bright magenta at maturity on the bracts and more or less on the branches and all parts exposed to the light. The bracts are nearly equal, or at least no one appears regularly throughout the plant to be two or three times longer than the others. The calyx is membranaceous and nearly always bright rose-colored. The wings on the back of the calyx lobes are thin and are much larger than the ascending lobes.

All of these characters vary. Otherwise there would be a specific difference. Color is of comparatively little value under different conditions of light and moisture but the characters of the calyx are reasonably constant.

The true Russian thistle, the same form which is causing so much trouble in North and South Dakota, has recently been received from Valentine, Nebraska, about seventy-five miles west of the Missouri river. It may be expected along railroads in all parts of the northwest, and care should be taken to kill it in these places before it goes to seed and becomes established.—L. H. Dewey, *Washington, D. C.*

EDITORIAL.

THE MEETING of the American Association for the Advancement of Science next month promises to be an important one for botanists. It will be remembered that this is to be the first assembling of the new section of botany which was established at the Rochester meeting. In order to justify the division of the section of biology, if for no better reason, it behooves botanists not only to attend in numbers, but to prepare papers concerning their late researches to be read at the meeting. The committee which was appointed to secure some papers which should give a comprehensive view of the condition of the science of botany in this country, especially for the benefit of those who do not yet realize its development, has been active, and as a result are able to announce a number of papers from some of the foremost botanists. Each one selected by the committee to treat his own particular field is able to speak with authority.

THERE WILL come before the section and the Botanical Club, also, several reports of important committees, such as the committee on the formation of an American Botanical Society, and the committee on revision of the nomenclature of spermaphytes. There will also be some new business for the botanists to take hold of, the most pressing of which is the consideration of some method of reporting and publishing a periodical index to American botanical literature.

IMMEDIATELY at the close of the general meeting comes the assembling of the botanical congress, the first session occurring on August 23d. It is expected that a considerable number of representatives of foreign societies will be present at this time and that the report of the international committee on nomenclature will be presented. It is to be hoped also that some steps will be taken to coöperate with the "international committee on the revision of biological nomenclature" (terminology) in order to secure the betterment of our present confused terminology which every teacher must feel as an "old-man-of-the-sea" about his neck when he endeavors to give his students an idea of homologies in plants.

ALTOGETHER there is an outlook for the science of botany at the present time which is full of encouragement, and an amount of work to be done for its further advancement which is enough to kindle the ardor of every man who has a gram-meter of energy or a spark of zeal. In no better way can this be shown at present than by making arrangements to attend the Madison meetings. The place is a beautiful summer resort, and the most ample accommodations are being made for the comfort and entertainment of those who attend.[1]

[1]Any one desiring information about railway and hotel rates, etc., can obtain it by addressing Prof. C. R. Barnes, Local Sec'y A. A. A. S., Madison, Wis.

THE REPORT of the success of the A. A. A. S. committee in securing a table for investigators at the Naples Zoological Station will be found on p. 283. As botanists were asked to coöperate in this endeavor, and did so coöperate, and as the Station makes generous provision for the study of marine and littoral plants, and as it is quite possible that a botanist may make application for the use of this table, it would have been a gracious, not to say a just, thing to recognize botanists in the formation of the advisory committee, which is at present composed entirely of zoologists.

Probably Secretary Langley was deceived by his knowledge of the English language into thinking that the American Morphological Society was not composed wholly of *animal* morphologists, and the Association of American Anatomists entirely of *animal* anatomists.

CURRENT LITERATURE.

Minor Notices.

In a monograph illustrated by two carefully prepared plates with forty-two figures, Dr. J. W. Moll publishes his results of a critical and exhaustive study on the karyokinesis of Spirogyra, together with a brief outline of the method used.[1] The latter is a most commendable feature, as no work of this kind can be thoroughly understood without some knowledge of the method pursued.

In the introduction, the author gives a comparative *résumé* of the results of several eminent observers upon the details in question.

Certain details in method are unique, and cannot be wholly without interest. Short pieces of Spirogyra threads are fixed in Flemming's mixture, and after thorough washing and bringing into 90 per cent. alcohol by means of a dialyser, they are imbedded in small bits of celloidin in order to facilitate handling and correct orientation. The bits of celloidin with the imbedded threads, are now stained with gentian violet, imbedded in paraffin and sectioned on a microtome.

The author deals at some length with the finer details of structure of the nucleolus and plasm, which, by this method, are brought out with great clearness. The view, held by several authors, that the nucleolus furnishes the chromatic substance, is supported. After a

[1] MOLL, J. W.:—Observations on karyokinesis in Spirogyra. Sep. from Verh. d. k. Akad. v. Wetensch. te Amsterdam. Sect. II, 1. no. 9 (repaged).

discussion of the facts which seem to justify the conclusion, Dr. Moll says: "The chromatic substance, which will form the segments at an early stage leaves the nucleolus and is transferred into the nuclear plasm. At this stage the nucleolus assumes a modified shape, getting pointed at one side and at this point the chromatic substance leaves it, appearing in the nuclear plasm as small fragments, ranged in an intermediate, achromatic thread like the beads of a necklace; and thus a skein, containing chromatic substance, is formed.

Doubt is expressed as to the origin of the thread linking the chromatic fragments together, but it is thought probable that the thread is first formed from the nuclear plasm and that afterwards the chromatin flows out into it. The author is inclined to think further that the process of karyokinesis in Spirogyra is not essentially different from that in higher plants.

Many other interesting and important details are brought out which can only be appreciated and understood by a careful reading of the entire paper.—D. M. M.

THE thirty-fifth contribution from the Herbarium of Columbia College is entitled "An enumeration of the plants collected by Dr. Thomas Morong in Paraguay, 1888–1890," by Thomas Morong and N. L. Britton, assisted by Miss Anna Murray Vail. It is reprinted from the Annals N. Y. Acad. Sci. VII. 45–280. Dr. Morong's expedition to South America is a record of unusual courage and devotion to science, and this bulky, well wrought contribution is one of its results. The study of such material is peculiarly difficult and can only be thoroughly done at a few favored places. In this case, recourse was had to the great collections of Europe before the work could be completed. Full notes in the field and in the herbarium largely increase the value of this contribution to the South American flora. Some idea of the wealth of material obtained can be had from the statement that nine hundred and thirteen phanerogams (distributed through one hundred and three families), and fifty-three pteridophytes are enumerated, eighty-three of the former being described as new species. The largest families are Compositæ (103), Gramineæ (91), Leguminosæ (87), Cyperaceæ (47, and only two of them carices), Euphorbiaceæ (36), Solanaceæ (36), and Malvaceæ (31). Euphorbiaceæ and Solanaceæ yielded the largest number of new species.

A RECENT CONTRIBUTION from the Gray Herbarium, of Harvard University is announced as no. III of a new series, two previous papers published by Dr. Robinson in Proc. Amer. Acad. being regarded as nos. I and II. The present one contains "Additions to the Phænogamic Flora of Mexico, discovered by C. G. Pringle in 1891–

'92," and is credited to the joint authorship of Dr. Robinson and Mr. H. E. Seaton. Thirty-four new species and varieties are described.

MR. J. CHRISTIAN BAY, of the Missouri Botanical Garden, has just published a bibliography of the tannoids, being issued in advance from the fifth annual report. Such publications are exceedingly useful, and become necessary for the preparation of monographs. It will be remembered that the same author has previously published a similar bibliography of inulin.

A CHECK LIST of the plants contained in the sixth edition of Gray's Manual has been compiled by John A. Allen and issued from the Herbarium of Harvard University. The species have serial numbers, including the varieties, and show a total of 3,781. An appendix attempts to enumerate the additional plants found within the limits of the manual since the issue of the sixth edition, bringing the total number to 3,937.

PROFESSOR A. S. HITCHCOCK has published a Key to Kansas trees in their winter condition reprinted from the 8th biennial report of the Kansas State Board of Agriculture.

OPEN LETTERS.

The bibliography of American botany.

With respect to a yearly bibliography and reference-work of American botanical literature, I have been asked to submit the following points to fellow-workers:

1. American botanical literature is playing a very important rôle in our science. Therefore it will be a very necessary step to take to publish a work similar to Just's Jahresbericht which could furnish:

(a) A list of papers and works in every department of botany, *absolutely complete.*

(b) A review of each of these papers and works, short and perfectly *objective.*

2. A work of this kind ought to be published every year.

3. In order to bring forth such a work, the importance of which would be international, it ought to be published and sold separately, and not be assimilated by any report or periodical. In the latter case it would to many botanists be inaccessible. With special reference to the Smithsonian publications I will state that in other countries these are very expensive and hardly ever seen in private libraries. A work on American botanical literature should be made accessible to every botanist all the world over.

4. Therefore, the publishing should, as far as the business management goes, be in the hands of a publisher.

5. The work ought to be undertaken by a committee, and the literature treated after some such plan as the following:

1. Periodicals, Reports of societies. 2. Text- and hand-books, nomenclature. 3. Classification. *a*, Phanerogamæ. *b*, Cryptogamæ. 4. Floras; *a*, of North America, *b*, of other countries. 5. Morphology. 6. Anatomy. 7. Physiology (including Biology and Phaenology). 8. Microscopy and Technique. 9. Biography. 10. Travels. 11. Horticultural botany. 12. Agricultural botany. 13. Forest botany. 14. Medical and Pharmaceutical botany. 15. Varia.

6. The editor of the work should be assisted by authors sending him a reprint of each of their papers. He should distribute these among the members of the committee for reviewing, and the reprints ought to become the property of the members to whom the editor sends them.

7. Not later than April each year the editor should have the reviews in hand so that the whole work could appear in July.

The details of this plan are easily understood. All of us know how valuable Just's Jahresbericht is, owing to the reviews, and how little attention it pays to American literature. Of course we must appreciate that such a work as has been planned above is an international affair, and for this reason especially, I have not the least doubt that it would pay the publisher well.

I should be glad to give some of my time to such a work, doing the purely bibliographical work, and taking care of the reviews of the literature bearing on the subjects named above under 6, 7, and 8. I would like to associate with fellow-workers, and form a committee which could bring the matter before the meeting at Madison. Owing to the amount of material that I have brought together, it would be possible, by properly attending to the matter to issue a report for 1892 this fall. —J. Christian Bay, *Missouri Botanical Garden.*

NOTES AND NEWS.

The Linnæan medal was recently presented to Professor Oliver, for many years curator of the herbarium at Kew.

Mr. D. T. MacDougal, recently assistant in botany at Purdue University, has been appointed instructor in vegetable physiology at the University of Minnesota.

Dr. Pax, of the University of Berlin, has been appointed Director of the Botanic Gardens at the University of Breslau, the position made vacant by the death of Dr. Prantl.

The University of Minnesota has established an inland biological station at Gull Lake. The lake is in Cass county, Minnesota, and the station is reached from Brainerd.

Miss Alice Eastwood, formerly of Denver, Colo., has succeeded Mrs. Katherine Brandegee, as curator of the Herbarium of the California Academy of Sciences, and as acting editor of Zoe.—*Zoe.*

A LIST of the Hymenomyceteæ of Orleans county, N. Y., has been published by Dr. Charles E. Fairman, in the Proceedings of the Rochester Academy of Science, II. 154–167. The lists contain 126 species.

THE MICHIGAN Agricultural College in its exhitbit in the Department of Liberal Arts at the Columbian Exposition is displaying the photographs of about 150 American botanists, together with a small number of foreign botanists.

IN THE *Bulletin de l'Herbier Boissier* I. 184–190, R. Chodat and O. Malinesco have published an article dealing with the polymorphism of the alga, *Scenedesmus acutus* Mey., accompanied by a plate illustrating this striking example of polymorphism.—BAY.

MISS FLORA N. VASEY, of the Department of Agriculture, Washington, D. C., is compiling a catalogue of all women doing *actual* work in botany either professional or amateur or both. Those wishing their names included will send full name and address with specialty to Miss Vasey.

IN *Grevillea* for June Dr. C. B. Plowright completes the life history of three Uredineæ, by showing that *Puccinia Festucæ* produces æcidiospores on Lonicera periclymenum, *Puccinia Agrostidis* on Aquilegia vulgaris and *Uromyces lineolatus* (found on Scirpus maritima) on Glaux maritima.

MR. ROBERT DOUGLAS, in a recent paper on coniferous forests read before the Nurserymen's Convention at Chicago, stated that "on the 500th anniversary of the discovery of this continent there will be choice evergreens in America, but like the buffalo, the elk and the antelope, they will be confined to public parks and private grounds."

BARON VON MUELLER proposes to prepare a volume completing Bentham's *Flora Australiensis*. His personal researches in Australia having begun in 1847 and his explorations having been continued ever since, he is pre-eminently prepared for such a work. It is a strange fact that this will be the first Flora for any of the great divisions of the globe.

A BIOGRAPHICAL SKETCH of Alphonse De Candolle, together with a complete bibliography of his writings is published in *Bulletin de l'Herbier Boissier* for April, having been prepared by H. Christ. The bibliography shows 229 titles, and it must be remembered that some of these titles represent large volumes, and in a few cases a series of volumes.

DR. DE CHALMOT has given[1] a continuation of his paper previously referred to here, and his results are the following: (1) The pentosanes decrease in the seeds during the germination, and appear again in the stems and roots; most probably they are transferred. (2) The total amount of pentosanes increases during germination, and it seems probable that seedlings can absorb them out of the soil. Pisum sativum and Zea Mays, as well as Tropaeolum were the material used.—BAY.

[1] Reprint from the American Chemical Journal, xv. 276–285.

THE NEXT meeting of the Australasian Association for the Advancement of Science will be held in Adelaide, South Australia, commencing on September 25, 1893, at which time South Australia will be at its best. There is no better time at which to visit Australia than when spring is merging into summer, and to naturalists this time of year is specially attractive.

DR. MAXIME SCHUMANN whose travels in Congo are well known has been at the Missouri Botanical Garden planning his long expedition in this country. He starts from Fort Smith, Kansas, and goes afoot as far as Albuquerque. From there he will go to El Paso, Mexico, and through that country, ending his tour at Vera Cruz. He intends to take a long time for this expedition.—BAY.

DR. JOHN M. COULTER has entered upon the Presidency of Lake Forest University, an institution with its preparatory and collegiate departments at Lake Forest, Ill., a suburb of Chicago, and its professional schools in Chicago. The large herbarium which he brought to Indiana University and so largely increased there goes with him to Lake Forest. Mr. Edwin Uline has been appointed Curator.

NUMBERS 82, 83 and 84 of "Die natürlichen Pflanzenfamilien" have just been issued. They contain Ochnaceæ and Stachyuraceæ by Gilg; Caryocaraceæ, Marcgraviaceæ and Theaceæ by Szyszylowicz; Quiinaceae and Icacinaceæ by Engler; Chlænaceæ by Schumann; Hippocrateaceæ by Lösener; Stackhousiaceæ, Staphyleaceæ, Aceraceæ, by Pax; Scrophulariaceæ by Wettstein; Lentibulariaceæ by Kamienski; Orobanchaceæ by Beck; Gesneriaceae by Fritsch.

THE SECOND SESSION of the Colorado Summer School of Science, Philosophy and Languages, will be held at Colorado Springs, Colorado, during the month of July, 1893. The botany will be in charge of Mr. Albert F. Woods, of the University of Nebraska. Mr. Woods' course will consist of lectures and laboratory work on the life history of typical representatives of the great groups of the vegetable kingdom, represented as far as possible by the flora of the region.

M. EPHREM AUBERT finds that the fleshy plants transpire less rapidly than other plants not only because of their form and mechanical hindrances to evaporation but because of the presence of organic acids in the Crassulaceæ and the Mesembryanthemaceæ, and of acids and gums in the Cactaceæ. The curve for water transpired by different regions of fleshy plants presents a minimum corresponding to the maximum of the curve of malic acid found in the same regions.

CHEMICAL AND physiological studies on the tannins have followed a course different from that of the older studies since the publications of F. Reinitzer and L. Braemer were issued (1889–'91), and since E. and O. Nickel improved the reagents hitherto employed. Professor Henry Trimble has just published the first volume of an extensive series of studies on these bodies, many of which have caused considerable trouble in the chemistry of plants.[1]—BAY.

[1] HENRY TRIMBLE:—The tannins; a monograph on the history, preparation, properties, methods of estimation, and uses of the vegetable astringents. With an index to the literature of the subject.—Philadelphia, 1892, Vol. I.

THE EXPERIMENTS concerning the assimilation of free nitrogen are still carried on in the Rothamsted Experiment Station. Sir J. B. Lawes and Professor J. H. Gilbert have published an important paper, reprinted from the Journal Roy. Agricult. Soc. of Engl. III. II. part iv, entitled, "The sources of the nitrogen of our leguminous crops." In the Rothamsted Memoranda for June, 1892, the plans of this well known station were published, and also a list of the papers hitherto published from the institution.—BAY.

ERYTHEA for May contains a first installment of new plants of the Pacific coast by Thomas Howell; notes on a new Californian *Fimbriaria* and on an interesting form of *Polypodium Californicum* by Marshall A. Howe; Professor Greene presents the first paper of a series entitled "Corrections in Nomenclature," replacing in the present one the untenable name *Jacksonia*, as applied by Robert Brown to an Australian genus of Leguminosæ, by *Piptomeris* Turcz. and changing the thirty-six species; also a long review, by the same writer of Professor Conway MacMillan's "Metaspermæ of the Minnesota Valley," in which the general tone of the work is commended and attention called to inaccuracies in bibliography.

A VERY complete investigation of the occurrence of starch and sugar, and the presence and function of diastase in leaves, is published in the *Journal of the Chemical Society* for May (pp. 604–677) by Horace T. Brown and G. Harris Morris. A good résumé of all previous work is given, with critical remarks. Their work warrants the opinion that the beginning of the change in the conversion of starch in the plant is dependent upon the action of the protoplasm, but that its continuance and completion is due to an enzym. They also conclude that cane sugar is an antecedent of the formation of starch by chloroplasts, and that cane sugar is translocated in the plant as dextrose and levulose, and the starch as maltose.

THE LABORATORY of marine biology of the University of Pennsylvania, at Sea Isle City, N. J., opens for its third season, during July and August. It has been thought best not to offer any special course of instruction during the coming season. There will be opportunities, however, for beginners by special arrangements with the professors and instructors who will be working at the laboratory during the season. The University especially desires that investigators and teachers of natural history shall avail themselves of the opportunities offered, and for them therefore no charge will be made except for glassware taken from the laboratory and reagents used. Students desiring instruction will be charged according to the amount of time devoted to them. The laboratory is very completely equipped both in the way of buildings and collecting apparatus.

LAST WINTER a memorial was circulated petitioning the Smithsonian Institution to support a table at the Naples Zoological Station. Thirteen copies of the memorial were sent out. Twelve bearing the signatures of nearly two hundred working biologists, representing about eighty universities, colleges, and scientific institutions, were returned and were presented in person to Professor S. P. Langley, secretary of the Smithsonian Institution. In response to the memorial the secre-

tary of the Smithsonian Institution announces that the Institution has secured a table at the Naples Zoological Station for the use of American investigators. Applications for the use of this table will be received at any time, and should be accompanied by credentials indicating that the candidate is qualified to carry on original investigation in some field for which especial facilities are offered at the Naples Station. These credentials should be accompanied by a statement of the history of the candidate as a student and investigator, together with a list of such original papers as may have been published by him. The application should be also accompanied by a statement of the character of the investigation which the candidate desires to pursue, and the dates between which he wishes to occupy the table.

Appointments will be made by the secretary of the Smithsonian for a specific period, and, in the consideration of the claims of the candidates, the secretary will probably avail himself of the counsel of an advisory committee of four, representing the National Academy of Sciences, the Society of American Naturalists, the American Morphological Society, and the Association of American Anatomists.[1]

Persons who may occupy the Smithsonian table are expected to make a report at the end of their term of occupation, or every three months in case of long residence at the station. It is expected that due credit will be given to the Smithsonian Institution in any publication resulting from studies carried on at its table, and the "Smithsonian Contributions to Knowledge" will probably be available for the publication of at least a part of the papers resulting from the Naples investigations.

All correspondence should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, D. C.

IN THE May number of the *Bulletin of the Torrey Botanical Club* Mr. Carlton C. Curtiss has presented some useful work in the examination of the surface characters of the seeds of some of our native Orchids, and has shown that while such minute anatomical characters may be of occasional use they cannot be exclusively relied upon in revealing genetic relationship; Professor Thomas C. Porter has published a list of the grasses of Pennsylvania as exhibited by that state at the World's Fair, numbering 166; the same author discusses *Solidago humilis* and its allies, delimiting *S. Virgaurea*, *humilis*, and *alpestris* and describing several new varieties of the first named species; Messrs. C. H. Kain, Thomas Morong, and Frederick Coville give short biographical sketches of Francis Wolle, Thomas Hogg, and Dr. George Vasey; Mr. F. H. Knowlton raises the question as to the proper place for the insertion of the interrogation point when used to indicate some question in reference to the plant-name; and Mr. John K. Small supplements his Revision of Polygonum by further notes and descriptions of new forms.

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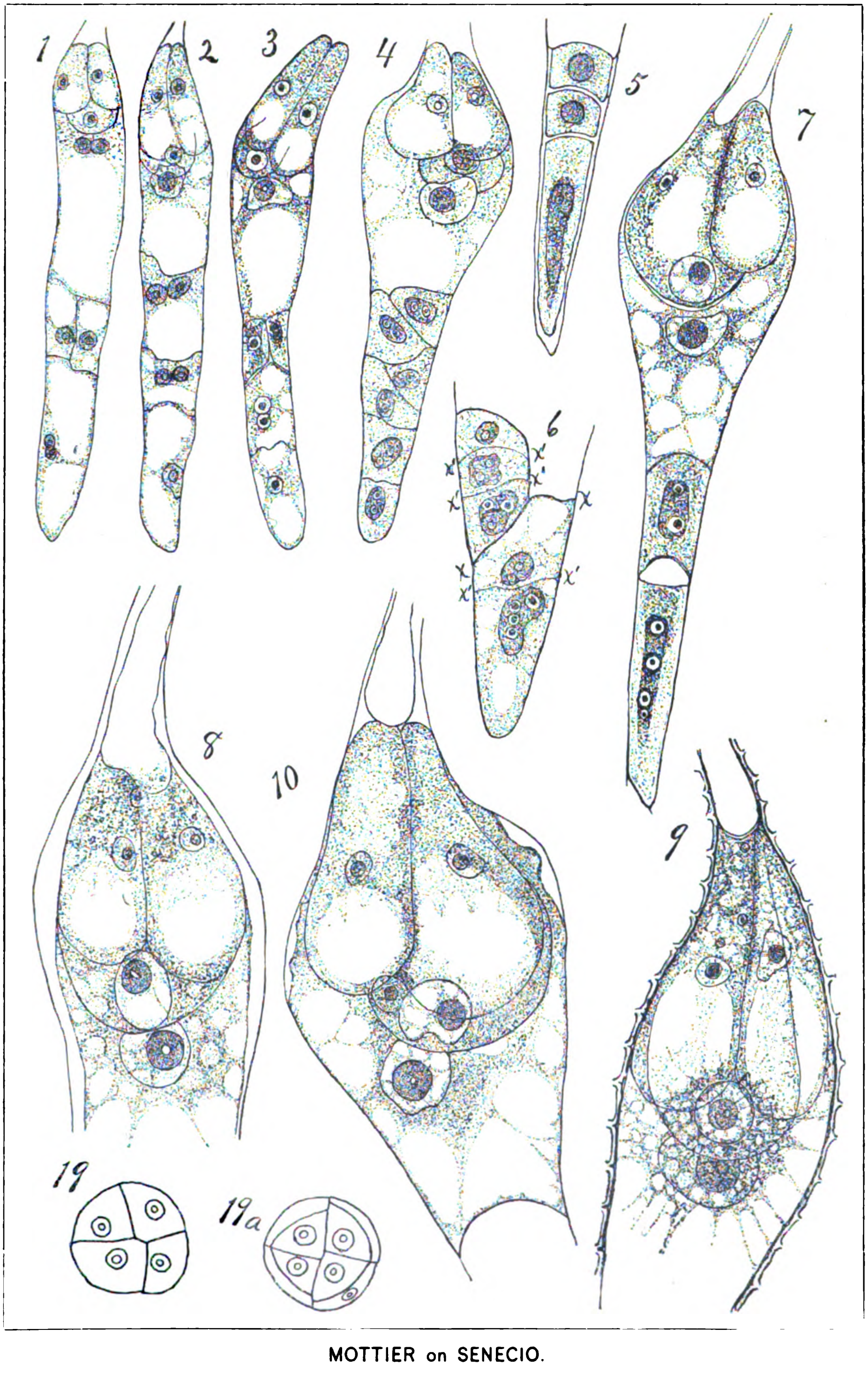
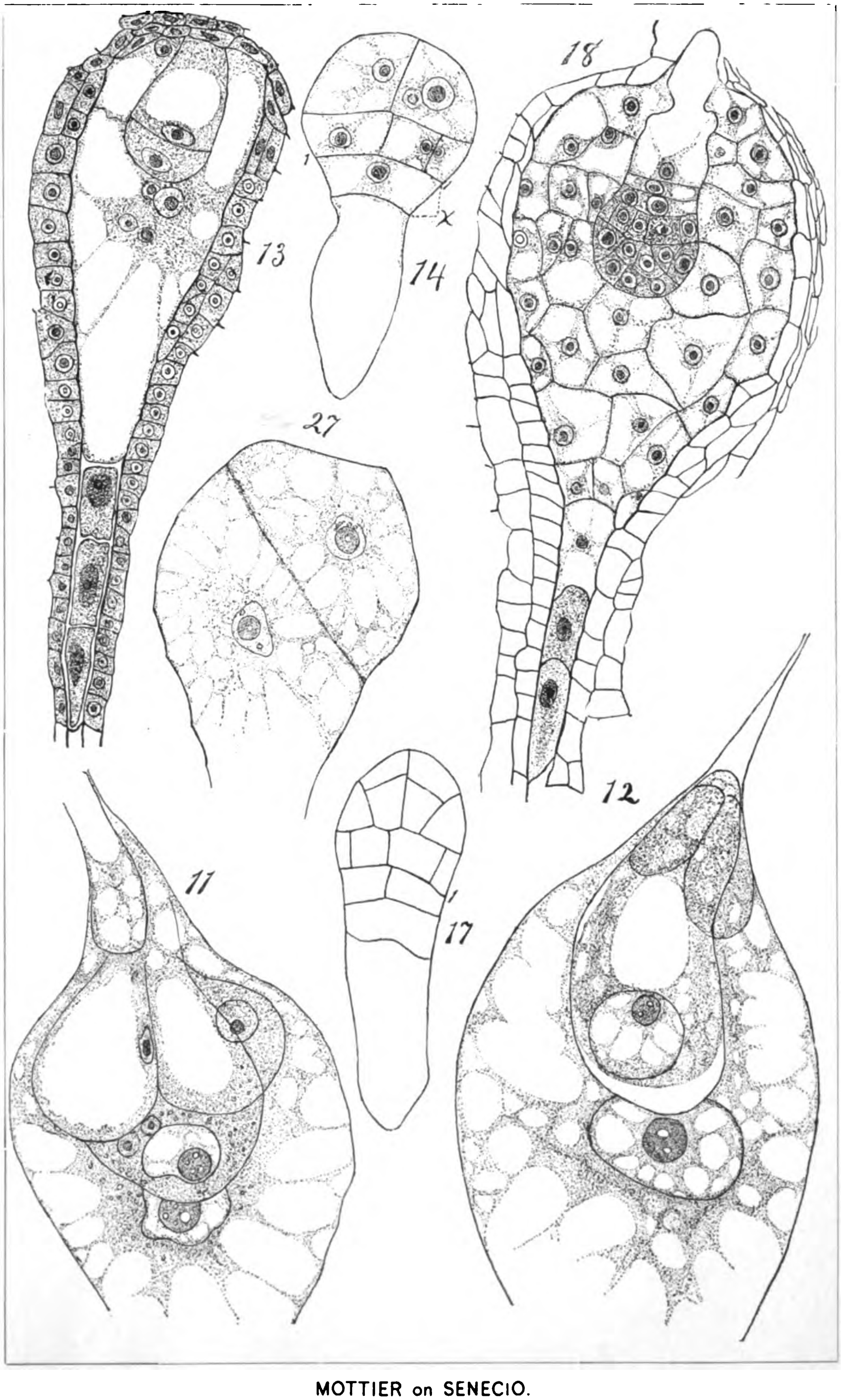
[1]This committee consists of Dr. J. S. Billings, of Washington, chairman; Professor E. B. Wilson, of Columbia College, New York; Dr. C. W. Stiles, of Washington, and Professor John A. Ryder, of the University of Pennsylvania.



MOTTIER on SENECIO.



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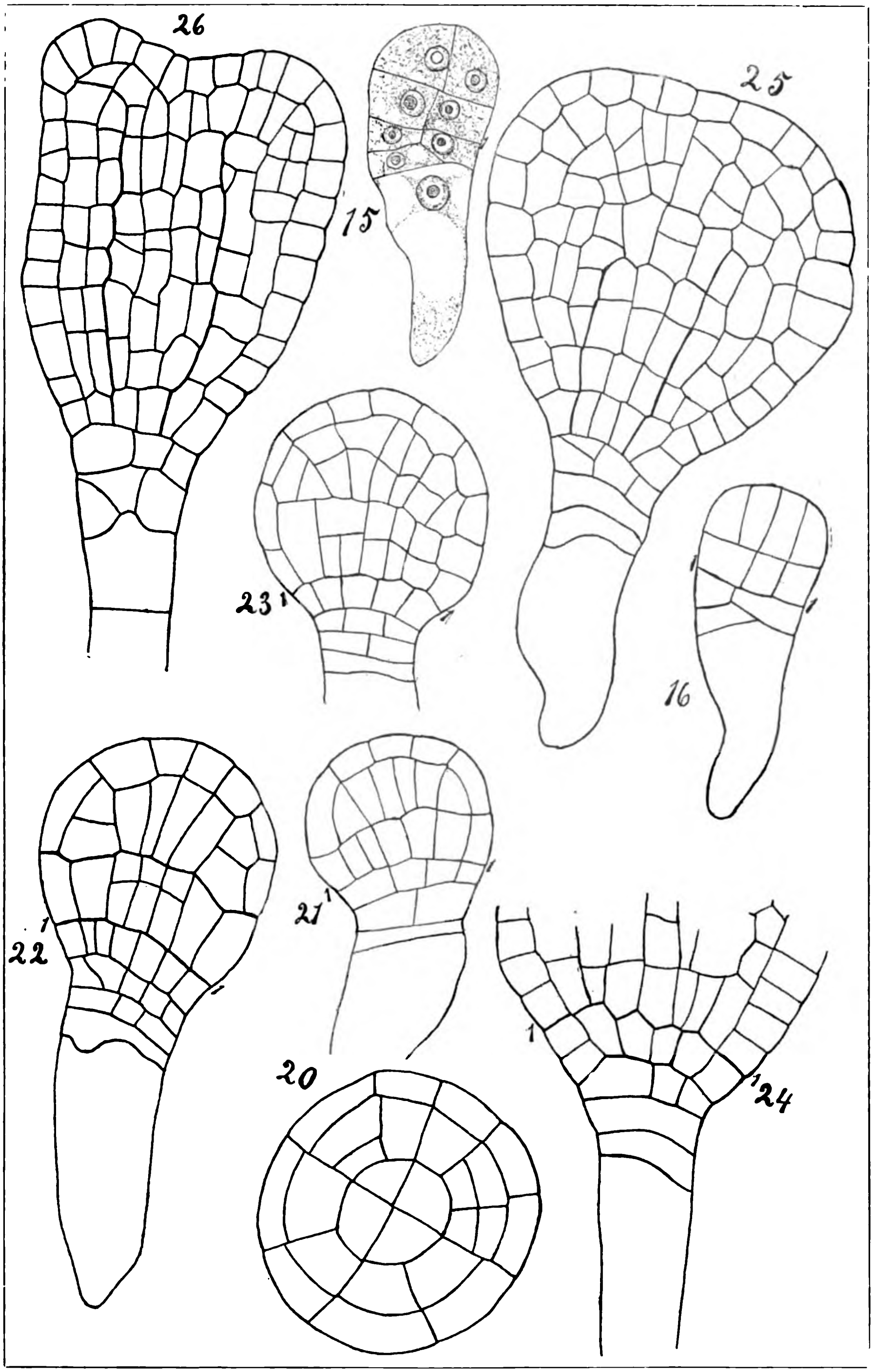

MOTTIER on SENECIO.

BOTANICAL GAZETTE

AUGUST, 1893.

Cell union in herbaceous grafting.

JOHN S. WRIGHT.

WITH PLATES XXX AND XXXI.

The plants mainly employed in this study were tomatoes, potatoes and geraniums, although some work was done with cactus, tradescantia, and a few other kinds of plants. The entire work was done in the winter and early spring of 1892, the experiments being performed in the greenhouse attached to the laboratory of vegetable physiology of Purdue University.

Three methods of grafting were employed, inarching, splice grafting and cleft or wedge grafting. It is needless to describe these well known methods here farther than to say that by the inarching method the scion is allowed to remain on the parent stock until union is formed, while by the splice and wedge or cleft methods the scion must from the start sever all connection with the parent and be sustained entirely by the new stock. In plants which are very delicate and of slow or uncertain union, the inarching method is the surer, though in most cases the cleft and wedge are safe and most convenient.

In all cases the stock and scion were held in place by thin strips of raffia until union was accomplished when they were removed to allow the diameter of the stem to increase.

It is only in certain stages of growth that herbaceous plants may be easily grafted; in quite young plants the tissues are not strong enough to survive the injuries inflicted in the operation, while in older parts, those past or nearly past the growing stage, the union does not take place readily because of the scarcity of meristematic tissue, as union depends upon the active growth of this tissue. In herbaceous grafting the rule is to use only such stems as will snap in breaking and

not crush at the point of yielding. The scions used in this work were in all cases vigorous growing young tips. In young plants the stocks were cut close to the ground, in older plants higher branches served the purpose.

In the experiments it was noticed that scions which had grown in vertical position more readily united with stocks which allowed them to retain their original position. Shortly after the operation of grafting many scions wilt and remain in a drooping state several hours or even a day, but with careful attention revive permanently.

Accounts were kept of each graft and when it arrived at desired age for study the parts at the point of union were cut into small pieces suitable for sectioning, dehydrated in a Thomas apparatus and prepared for sectioning by the celloidin method.

Although all grafts were recorded so that sections might be had showing grafts at various ages and all stages of cell union, study of sections showed that in most instances all stages of cell union could be found in a single graft. Longitudinal and transverse sections were made of most grafts, but the longitudinal section seldom showed anything in addition to that shown by transverse sections. Camera lucida drawings were made of all sections of importance, and in connection with the slides used for study. A number of these drawings have been selected to illustrate this article.

Graft of tomato on tomato.—Two lateral and parallel tomato branches belonging to separate plants had tangential slices, each about three-fifths of an inch long, removed from their adjacent sides; these cut surfaces were bound firmly together with raffia so that similar tissues met. After about four weeks the graft was sectioned for study. The cross section showed the line of union marked by a ragged brownish wall, which passed with but one interruption entirely across the stem. In longitudinal section this junction of the two members was marked by rows of small irregular parenchyma cells with here and there the intervention of a thickened brown wall (fig. 1). The sections showed that the cells which had been injured in grafting had died, while those immediately beneath them were stimulated to a vigorous growth forming meristematic tissue in each member, which in its advance pushed the broken walls of the dead boundary cells into line, forming between the two members of the graft the fragmental

brown wall noted in the section (fig. 2, *l, l*). This brown wall in all the instances observed was unaffected by stains used on the section. As will be seen farther on, this wall tends to disappear with age until at last only a mere trace of its existence is left.

In this case the tangential slices, removed in bringing the stock and scion into shape for grafting, carried with them a part of the woody zone of each internode, so that in cross-section the remaining part appears horseshoe shaped. In binding the scion to stock the tips of these woody rings were bound closely together (fig. 3), but in process of union parenchymatous tissue developed and intervened between the woody zones of the two members, resulting in their wide separation, as seen in figs. 2 and 4.

In sections of potato grafted to potato no new points were noted, the union occurring by the process described in the previous case, except that the brown wall which so strongly marks the junction in the case of the tomato was not nearly so prominent.

Potato and tomato graft.—The cross section of a wedge graft of a potato to a tomato, five weeks old, showed that similar tissues in stock and scion had met in the union. At the time of grafting numerous gaps and small spaces existed between the two members of the graft owing to the irregularities and unevenness of the cut. The parenchyma cells of stock and scion had elongated towards these places, being the direction of least pressure, and had filled up most such cavities, the line of meeting of stock and scion tissues being indicated by a wall twice the thickness of the ordinary cell wall. In other places this wall was very ragged and fragmentary due to dead cell walls which had been crowded into line by the growing tissues; shown in fig. 5.

The growth of the cells in closing up gaps is similar to growth of meristematic tissue induced by surface wounds. The cells just outside the path of the knife elongated in the direction of the severed surface to double the ordinary dimensions or more, then formed a series of transverse walls making what appeared in cross section to be series of narrow plate-like cells, the larger walls of which were parallel to the cut surface, the longer dimension being equal to the width of the cell from which they originated. (See figs. 5, 11, etc.) At the outer part of the section the central parenchyma of the stock was shown to

have met the cambium of the scion while the cambium of the stock met the parenchyma of the primary cortex in the scion. The union here was easily accomplished through development of meristematic tissue. The section showed the central parenchyma to have been more active in forming a union than was the primary cortex.

In one case where a potato scion had been grafted to tomato stock the central parenchyma of the tomato stock was bound against soft bast cells of the fibrovascular bundle. The bast cells had swollen as if attempting to enlarge, the cambium of the vicinity began an active growth, and a considerable quantity of meristematic tissue intervened between the central parenchyma and the bast cells of the fibrovascular bundle (fig. 6).

In one instance the knife in preparing the parts for grafting, had removed one side of a cell in the potato scion, while a cell of the stock had suffered a similar loss, and it happened that the free portions of the severed walls of these two cells were bound end to end. Through continued pressure the two partial cells had united, forming a cell twice the normal size, which lived and grew. This large cell, however, threw a delicate wall across its middle, forming two cells each of normal size, and providing such a neat union between stock and scion that it was almost impossible to detect it, the path of the knife showing no thickened wall, with but here and there a few fragments of dead walls projecting into the newly formed cell. See fig. 7.

The graft which presented the above interesting union also showed in an admirable way the action of parenchyma cells in closing up spaces existing, immediately after the operation, between members of the graft.

As previously stated the removal of pressure from one side of the cells both stimulates growth and induces elongation of the cells in the direction of least resistance. In this graft the cells had elongated towards the injured surface until their length was four times their width; delicate walls were then passed transversely across the cells dividing them into a series of small cells. These transverse walls appeared near the free end of the cell at first, and when any variation of size occurred in the smaller cells, as was often the case, the one most remote from the injured surface was the largest. Close examination revealed, in many instances, delicate young walls pass-

ing through the young cells at right angles to their longer axes. The free sides of these growing cells were much more thickened than the others (fig. 8).

The cross section of another graft of potato on tomato showed the central parenchyma of the tomato joined to the soft bast, cambium and fibrovascular bundles of the potato. Although the line of union was marked by a slightly thickened wall, no gaps were present and no development of meristematic tissue occurred. The junction of the two members was so neat as to be no more marked than the transition from one tissue to another in the same plant (fig. 9).

Geranium grafts.—Geraniums were grafted to each other with great ease. The action of these cells in effecting union, with occasional modifications, was similar to that seen in previous grafts of potatoes and tomatoes. Thickened brown walls generally marked the junction of the tissues, as in the former grafts; in some instances where gaps existed in this wall the cells of the stock and scion had so grown together as to wholly obliterate the path of the knife. In such places the longer axes of the cells were nearly at right angles to the line of junction (fig. 10).

Geranium and tomato grafts.—Geranium scions were easily united to tomato stocks, the geranium in nearly every instance thriving and increasing in foliage. The tomato scions would in no instance, however, accomplish union with a geranium stock. The repeated trials proved that in respect to grafting the two plants do not act reciprocally. As a partial explanation of this two facts are offered, viz: difference in the relative quantities of sap in tomato and geranium, and difference in acidity. The geranium has relatively much less sap than the tomato and in addition to this the sap is of greater acidity, so that in grafting osmotic action is set up between the tomato scion and geranium stock in which the tomato loses sap and at a time when it is least able to stand it and consequently perishes; in case of geranium scion and tomato stock the osmotic action would result beneficially to the scion supplying it with more sap at a time when it was in greatest need. Cross sections of these grafts showed the geranium to have been more active in the formation of the union (fig. 11).

Geranium and potato grafts.—Successful grafts were made with geranium scions to potato stocks. In this case as in the previous one the geranium was more active in forming the union,

as shown by the cells along the line of junction of the two members (fig. 11). In this graft the wall which marked the line of union was thickened but otherwise similar to ordinary cell walls.

Cactus grafts.—Cactus grafts were made, and sections showed the method of union to be essentially like that in the other cases studied. The union occurred in either one or the other of two ways: long continued pressure holding cell walls in contact gradually causing them to cohere, or through the development of meristematic tissue by each member.

Grafts of a monocotyledonous plant.—The only monocotyledonous plant experimented upon was *Tradescantia zebrina*, which was grafted to itself with great ease; and with much surprise it was also found to form a true union with a tomato stock. In grafting tradescantia to itself the members of the graft were firmly bound, and healing was rapidly accomplished. The examination of cross sections showed no general development of meristematic tissue so prominent in previously described grafts. Those parts of boundary cell walls which were on the line of union were very much thickened and from all appearances most of the union had been effected through long exerted pressure which caused the cell walls permanently to cohere. Where gaps or spaces had existed however elongation of cells in that vicinity had occurred as in other grafts. Where parenchyma met a fibrovascular bundle, and a space existed between the two, the parenchyma cells elongated towards the gap and divided, giving rise to new cells until the space was closed and the union accomplished through pressure of the cell walls as in previous cases.

Union of tradescantia and tomato.—In cross section of a graft of tradescantia upon tomato the union was found to be as perfect as any between tomato stock and potato scion. In many places tissues of both members gave evidence of marked activity in forming union, in others the outlying walls of border cells were thickened and union here was shown to have been the result of pressure of the border cell walls upon each other. The tomato was the more active in forming the union (fig. 12).

Examinations of callus.—Examinations of callus in tomato and potato slips, which had been placed in damp sand, were made in order to see what relation exists between the healing of these external wounds, and of the internal wounds of grafts.

The short account here given is from the examination of potato callus, as it showed all the parts clearly. From a longitudinal section it was seen that all the cells injured by the knife died, the parenchymatous tissues immediately beneath were vigorous and were stimulated to renewed growth. Elongation towards the cut surface occurred in the cells, and by forming successive transverse walls each elongated cell gave rise to several small cells, which rapidly increased in thickness of cell wall, and became rounded. These small cells pushed the dead cells in advance as they grew, and soon enveloped the entire injured tip and extended upward enveloping the sides of the branch with a mass several layers thick. The walls of the callus cells are thicker than those of the parenchyma cells, which give rise to them, and the cell contents are richer in protoplasm. The outer callus cells give rise to root hairs (fig. 13).

At the tip the transition from callus cells through meristematic tissue into ordinary central parenchyma is very gradual. The examination of the tip showed the first stages in the formation of callus to be similar to those in effecting union of tissues by grafting. Hansen, who has carefully studied the formation of callus, regards a cut made in a stem, when vegetative conditions are favorable, as a stimulus to extensive and complex activities. In the cut necessary to grafting we have the stimulus to growth, the parenchyma cells respond to the stimulus by developing meristematic tissue which in most cases effects the union.

More or less true callus may be found in the graft serving to protect injured parts which by reason of their position could never unite. If proper conditions of moisture be present the graft also frequently gives rise to rootlets as does the callus. The union of tissues in the graft and formation of callus is similar. Like causes produce each. One is the healing of an internal the other of an external wound. The callus may exist on the graft, and parenchyma which in one place produces a callosity to protect an exposed injury, in an adjacent locality effects a union between stock and scion, the process in each case being similar.

Summary.—We find that union in herbaceous grafting occurs in one of two ways: It is accomplished either by long exerted pressure holding old cell walls together and gradually causing them permanently to cohere, or through the develop-

ment of meristematic tissue by one or both members of the graft, after which the boundary walls meet and unite through pressure, somewhat as in the first case. We generally have part of the union in any particular case formed by the coherence of the walls of old cells, and the remainder formed by the growth of new cells arising, as in the case of callus, back of the cells injured by the knife.

Broken walls of the injured cells are thus pushed into line forming a brownish fragmentary wall marking the junction of the two parts of the graft. This wall tends to disappear with age; the smaller young cells along the junction of the two members enlarge rendering the line of demarkation between the two tissues faint.

In cases where the severed ends of two woody zones met, but were not sufficiently close to allow of union through coherence of cell walls, the two opposite ends of woody zones were enveloped by meristematic tissue arising from the cambium layer on the one side and the central parenchyma on the other. These two layers of meristematic tissue, meeting each other between the ends of the woody zones united as in the preceding cases, except no fragmentary wall separated them. When such a process occurred we had the woody zones of the two members of the graft separated by a layer of parenchymatous tissue similar in general form to a medullary ray. In cases where the woody cells met parenchyma cells for union they were often first enveloped by a growth of the neighboring parenchymatous tissue of the member of the graft to which they belonged.

It may be interesting to account for the transferrence of water from the stalk to the scion. The work of transferring water from one part of a plant to another is done largely by woody tissue, parenchyma being unable to do it. If parenchyma intervene between the woody tissues of stalk and scion throughout the graft the water supply of the scion is cut off. But this intervention did not occur throughout the graft where successful union was accomplished; while some sections did not show direct contact of the woody systems, others of the same graft always disclosed it. In dicotyledonous plants the binding of the graft nearly always brought the ends of the rigid woody rings in direct contact. In grafting of monocotyledonous to dicotyledonous plants, as in tradescantia and tomato graft the scattered woody bundles of the tradescantia

were often seen in direct contact with the woody cells of the tomato, thus giving opportunity for the transferrence of water from the one to the other.

Naturally one would not expect union between plants of different orders, and the successful grafting of *Tradescantia zebrina* upon tomato and of geranium upon tomato was a surprise. The union of tomato, a dicotyledonous plant, and tradescantia, a monocotyledonous plant, was particularly interesting and points to the fact that a similarity in the arrangement of the woody and other tissues is not essential in grafting herbaceous plants.

Opportunity is here taken to thank Dr. J. C. Arthur, of Purdue University, for his kind assistance in the preparation of this article, the work upon which it is based being done under his supervision.

Botanical Laboratory of Eli Lilly & Co., Indianapolis, Ind.

EXPLANATION OF PLATES XXX AND XXXI.

Abbreviations used: *l, l,* line of union; *G,* geranium; *T,* tomato; *P,* potato; *Td,* tradescantia.

PLATE XXX.—Fig 1, Long. sec. of *T* to *T; n* young cells formed in process of union.—Fig. 2. Trans. sec. of *T* to *T; w, w,* woody zone; *cp, cp,* central parenchyma: *cp'* cortical parenchyma; *m,* young cells.—Fig. 3. Trans. sec. *T* to *T; w, w,* woody zones; position of *w, w,* shown at time of grafting.—Fig. 4. Trans. sec. *T* to *T,* showing position of *w, w,* after graft had healed.—Fig. 5. Trans. sec. *P* to *T,* through central parenchyma; *n, c,* young cells.—Fig. 6. Trans. sec. *P* to *T; cm,* cambium tissue; *b,* bast cells.—Fig. 7. Trans. sec. *P* to *T,* through central parenchyma; *n,* young cell walls; *a,* fragments of broken walls formerly occupying places of *n.*—Fig. 8. Trans. sec. *P* to *T,* showing growth of tissue and formation of young cells, *n, n,* in closing up gaps, *gp, gp; t, v,* young transverse walls dividing young cells; *t, t,* thickened walls of boundary cells.

PLATE XXXI.—Fig. 9. Trans. sec. *P* to *T; sb,* soft bast cells; *c m,* cambium layer.—Fig. 10. Trans. sec. *G* to *G. m m,* newly formed cells; *n n,* distorted parenchyma cells.—Fig. 11. Trans. sec. *G* to *P; n,* young cells.—Fig. 12. Trans. sec. *Td* to *T; f, b,* fibrovascular bundle; *n,* young cells.—Fig. 13 Long. sec. callus formation. *c, c, c,* on potato slip: *w,* fibrovascular bundle; *b,* bast cells; *c, p,* central parenchyma: *br,* the broken walls of cells injured in cutting the slip; *k,* formation of callus cells by parenchyma cells; *h,* trichome arising from callus cells.

Observations on the zoospores of Draparnaldia.

L. N. JOHNSON.

WITH PLATE XXXII.

Having been interested during the past season in studying various algæ I have been surprised at the lack of accurate descriptions of the zoospores and their mode of formation. Aside from the familiar papers on *Ulothrix zonata* little seems available, beyond scattered references in various text books.

The plant selected for special study was *Draparnaldia plumosa* Ag. Concerning this genus little information can be gleaned from the accessible books. The accounts by the older writers are chiefly interesting historically. For instance Decaisne[1] in 1842 spoke briefly of the zoospores, and figures them though with no attempt at detail. He says that he failed to see any motion of them either before or after their escape from the cell. It is possible that he saw only resting spores.

Kuetzing, in his "Metamorphose des vegetaux inferieurs,"[2] mentions finding Draparnaldia producing zoospores on one occasion, but lost the material before making any detailed study of them. He speaks with regret of thus failing to have the opportunity to investigate the vexed question whether zoospores were really animals. Before this Treviranus had observed the zoospores and shown that from them grew young plants of Draparnaldia.

Derbes and Solier, in a paper published in 1850,[3] gave a brief but concise account of the zoospores in the closely related *Stigeoclonium tenue* Kg.

Aside from these references there is nothing available, at least to the average botanist. This being so it has been thought desirable to give a somewhat minute account of the structure and formation of the zoospores in the species mentioned.

The form of the plant is probably familiar to every botanist. The main axis is comparatively stout, and is made up of cylindrical or barrel shaped cells, with the walls lined by a

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[1] Essai sur une classification des algues, etc. Annales des Sc. Nat. Bot. II. XVII. 314.

[2] Annales des Sc. Nat. Bot. II. XI. 136.

[3] Organes reproducteurs des algues. Ann. des Sc. Nat. Bot. III. XIV. 267.

central transverse band of chlorophyll, containing several pyrenoids. On the sides of this axis and its main branches are borne numerous smaller branchlets, each itself branching copiously into a plumose tuft. The cells of these branchlets are shorter and their chlorophyll covers nearly the entire wall. Toward the end of the ultimate branchlets the cells are much longer, with the narrow chlorophyll band central. The young branchlet is tipped with a long hyaline multicellular seta.

The production of zoospores is confined to the branchlets, but to no particular part of them. Often the contents of all the cells of a branchlet become thus transformed, and it is not uncommon to find a vigorous plant changed in a single day to a naked axis surrounded by the empty cell walls of its branchlets.

The zoospore is ovate or oval in form (fig. 1) and averages about $12–16 \times 8–10\mu$, though there is much variation in both form and size. The anterior end is rather pointed and nearly hyaline. On the tip are attached the four cilia, each rather longer than the body. The chlorophyll is parietal, but not uniformly distributed, and contains one or more pyrenoids. There is a bright red pigment spot, lanceolate in outline and apparently slightly raised above the surface. It is usually placed about on the middle of the side of the zoospore, in a diagonal position. It is always connected with the chromatophore, and in one case was observed at the very base of the body. At the anterior end of the zoospore there are two large contractile vacuoles, placed side by side and contracting alternately. Repeated observations showed that the average interval between two contractions of the same vacuole was about fifteen seconds. After contraction the vacuole often seemed invisible for about six seconds, then appeared and expanded gradually for ten to twelve seconds, when it suddenly and rapidly contracted. Occasionally the contraction was slower, occupying nearly a second.

Only a single zoospore is formed in each cell. The first sign of their production is apparently the formation of the pigment spot. This seems to be fully formed at least twenty-four hours before the escape of the mature zoospore, but the manner of its formation could not be determined. One can often find a branchlet differing apparently in no respect from those around it, except that each cell bears in some part of

its interior this bright red spot. This is especially striking when seen in one of the long terminal cells where the chromatophore lines but a small portion of the cell wall. In some cases the cells at this stage seem to have the contents slightly more granular than usual. The contents continue ordinarily to occupy the whole cavity of the cell wall up to the very instant of escape, though occasionally the zoospore assumes a somewhat rounded form while still within the mother cell. It is difficult to determine the exact time of formation of the vacuoles, but in every case where a vacuole was observed pulsating the zoospore escaped in less than fifteen minutes.

The escape of the zoospores takes place normally in the morning, and most abundantly from eight to ten o'clock, though not infrequently occurring at any hour of the day. Specimens collected in cold weather and brought into a warm room soon begin to discharge their zoospores in abundance, regardless of the time of day. They seem to be formed at all times of the year, having been observed by the writer in nearly every month.

There is usually no motion or change in the appearance of the zoospore to denote that the time of escape is at hand. Suddenly the wall gives way at one point, and through the opening bursts the zoospore, the hyaline end being invariably first to appear (fig. 2). The whole zoospore may escape almost instantly, or the process may be prolonged for at least a quarter of an hour. In a few cases the zoospore was seen with its anterior end protruding slightly from the small opening, and vigorously twisting, with a boring motion, apparently trying to force its way out. If the opening is not large enough for easy escape, the zoospore assumes a dumb-bell shape, the body gradually squeezing through. Figures 3 and 4 represent a specimen in which the escape was rather rapid. Just as the first drawing was finished there was a sudden bursting of all the cells, and every zoospore thrust its colorless end out. The other drawing (4), showing the same cells two minutes later, was hastily outlined, and in four minutes every cell was empty.

The zoospore is often held even after its body is free, by its cilia, which seem to get caught either inside the cell or by the mucilage covering it. Then follow violent struggles to get free. The opening in the cell wall seems to be produced, in part at least, by absorption of its substance, for no projecting edges can be seen.

As soon as the zoospore is free it darts rapidly away, with a rotary motion, and keeping the hyaline end forward. Under the microscope it never moves far in the same direction, but seems to turn at random. It is almost impossible to determine with any degree of accuracy the rate of their motion, but the result of repeated trials indicates an average velocity of about 6^{mm} per minute.

The period of activity does not seem to be very long—in no case observed longer than seven minutes. Judging from the distance to which they sometimes travel it must often be rather longer than this. At the end of the period the motion diminishes in velocity, and the body begins to rotate around the hyaline end. This motion soon grows slower, and after a few final quivers it ceases. In settling down the zoospores show a tendency to collect in groups like that shown in figure 5, or to attach themselves by their hyaline ends to bits of gravel, the larger filaments of the plant, or in fact any object which comes in their way. One often sees old plants completely covered by the masses of zoospores fastened to them. No signs of conjugation have been seen, but most of the zoospores germinate freely.

The contraction of the vacuoles ceases soon after the zoospore ceases its motion, and the cilia disappear. The cell quickly begins to elongate and a slight disc is formed on the hyaline end, by which it clings to the substratum. A cell wall forms around the hitherto naked mass, and the free end of the cell becomes pointed as it elongates. The elongation takes place above the pigment spot, leaving this near the point of attachment. The first cell division may take place in a few hours or may be delayed for several days. This divides the spore in such a way that the pigment spot always remains in the basal cell (fig. 7). It may persist till four or five cells have been formed (fig. 9), when it begins to grow fainter, and seems to be absorbed. About this time the basal cell begins to form an hyaline filament, which grows rapidly over the substratum, and serves as a hold-fast for the young plant.

By the time the filament has reached a length of ten or twelve cells the tip has elongated into a multicellular bristle, which growing rapidly soon becomes several times as long as the filament (figs. 10, 11). Of course the growth of the filament must then be intercalary. From this point the young

plant grows rapidly, and soon becomes large enough to begin the formation of another generation of zoospores, which it does almost before the main axis has been developed.

One of the most interesting and striking peculiarities of the zoopores is their behavior toward light. It has been said that they appear chiefly in the morning, but this is apparently due, in part at least, to the change of temperature, for it was proved by experiment that they were produced quite as abundantly in a perfectly dark box as in the bright light outside. The effect of the darkness seemed to be to slightly retard the time of formation, making its maximum about ten o'clock in the morning (in winter). The optimum temperature of the water seems to be about 17° C.

Like most other zoospores these are heliotropic, swarming toward the light in such numbers that the side of the vessel becomes coated with them. Various experiments were performed to determine whether this action was really due to the light or to the heat. The result of these experiments was to show that it is the light rays which influence them, though in some cases it seemed that the zoospores were slightly affected by the heat.

It may be well in closing to state that in autumn many plants were found whose filaments were transformed into chains of resting spores. These differed little in general appearance from zoospores, excepting that they lacked the pigment spot and vacuoles, and that their contents seemed uniformly distributed in a parietal layer. This was nearly homogeneous and contained several pyrenoids. They do not seem to leave the parent cells, but germinate, the shoot bursting through their wall. The appearance of these resting spores suggests that they are modified zoospores, but in none could any pigment spot be detected or any other proof of such an origin.

University of Michigan, Ann Arbor.

Explanation of Plate XXXII.

Figures 1-8 × 1150. Figures 9-11 × 850. All reduced one-third in engraving.

Fig. 1. Mature zoospores.—Fig. 2. Filament, showing zoospores in the act of escaping.—Figs. 3, 4. Two cells showing condition before and during escape of zoospores. *v*, vacuole. *p*, pigment spot.—Fig. 5. Cluster of zoospores, showing characteristic grouping as their motion ceases.—Figs. 6-11. Showing growth of young plant from zoospore.

New and noteworthy North American plants.

JOHN M. COULTER AND ELMON M. FISHER.

1. RANUNCULUS LAPPONICUS L.—The range of this arctic species is usually stated as "Lat. 50° and northward." Professor Macoun extends its range somewhat southward, in recording it from Prince Arthur's Landing, Thunder Bay. We now have it from the Lake Superior region of Minnesota, where it was collected by Mr. L. S. Cheney, of the University of Wisconsin, twenty miles northeast of Grand Marais. Mr. Cheney's specimens were collected in the same region as the imperfectly known *Anemone nudicaulis* Gray, which Dr. N. L. Britton has shown to be Ranunculus Lapponicus.

2. **Petalostemon glandulosus,** n. sp.—Glabrous and glandular throughout: stems herbaceous, striate, leafy, 2 to 6^{dm} high, from a somewhat woody base: leaves 2 to 4^{cm} long; leaflets six to twelve pairs, oblong or oblong-obovate, 5 to 6^{mm} long, obtuse or retuse, conspicuously black dotted beneath: spikes cylindrical, very dense, 4 to 9^{cm} long, on usually slender peduncles (5 to 8^{cm} long): bracts very narrow, long acuminate, much longer than the calyx: calyx rose-tinged, tipped with green, conspicuously glandular, 3 to 4^{mm} long, deeply lobed, with the very minute greenish teeth pubescent on the margins: petals white, linear, almost three times as long as the calyx; the vexillum broadly cordate: pod pubescent above.—Eastern Texas, at Hockley (*F. W. Thurow*, in 1890), and at Industry (*H. Wurzlow*, in 1892). Apparently nearest *P. candidus* Michx., in fact has probably been distributed as that species; but differs in being strongly punctate throughout, in the more numerous and short-oblong leaflets usually acutish spike, early deciduous bracts, and the prominently glandular strongly oblique calyx with much shorter teeth.

3. **Astragalus strigosus,** n. sp. — Whole plant grayish with coarse appressed pubescence, erect, 17 to 25^{cm} high, leafy, with many very slender stems from a somewhat woody base: stipules triangular, acuminate; leaves 7 to 11^{cm} long, with thirteen to twenty-one sessile acute narrowly linear to almost filiform leaflets (1 to 2^{cm} long): peduncles much shorter than the leaves, together with the elongated raceme (with ten to sixteen distant flowers) 10 to 15^{cm} long: flowers purplish, 1^{cm} long: calyx very strigose, the

subulate linear teeth about equalling the tube: pod linear, 18 to 20^{cm} long, about 3.5^{mm} broad, sessile. — Basin, Montana, July, 1892, *F. D. Kelsey.* One of the SCYTOCARPI, and nearest *A. flexuosus* Dougl., but distinguished by its many slender stems and leaves, linear and acute sessile leaflets, shorter peduncles with more elongated racemes, calyx with longer and linear teeth, wings with a short broad and acute appendage, and sessile pod.

4. **Astragalus atropubescens,** n. sp.—Stems and leaves grayish with appressed pubescence, becoming black hairy in the inflorescence and especially on the calyx: stems erect, 3.5 to 5^{dm} high, with very many slender stems from a woody base: stipules lanceolate, acute; leaves few, 13 to 20^{cm} long; leaflets twenty-one to thirty-three, linear-oblong, glabrate above, 15^{mm} long, cuspidate, very blunt (seldom retuse), short-petioled, usually with a cuneate base: peduncles much shorter than the leaves, together with the scarcely elongated (eleven to sixteen-flowered) raceme 12 to 20^{cm} long: flowers declined, ochroleucous, 1.5^{cm} long: calyx oblique, very black with appressed hairs, 5 to 6^{mm} long, the subulate teeth half as long as the tube: vexillum and wings much longer than the keel: pod linear-oblong, coriaceous, erect, stipitate (stipe 5^{mm} long), glabrous, straight, 2^{cm} long without the stipe, 5^{mm} broad, acute at base, acuminate at apex, deeply grooved on the back but not completely two-celled, the ventral suture scarcely acute.—Deer Lodge, Montana, June, 1892, *F. D. Kelsey.* The species seems to belong with the GALEGIFORMES but it has an erect pod and is not so leafy. In addition to the characters just mentioned it differs from *A. Drummondii* Dougl. in its appressed pubescence, much more black hairy calyx, and shorter linear-oblong pod; and from *A. scopulorum* Porter in its much more black hairy calyx, much shorter and acuminate straight pod with simple deep dorsal sulcus.

5. **Hedysarum flavescens,** n. sp.—Erect, 3 to 4^{dm} high, minutely pubescent: stipules connate, opposite the petiole; leaflets five or six pairs, oblong-elliptical, 1.5 to 2^{cm} long, slightly pubescent beneath: racemes fifteen to thirty-flowered, short, rather dense, elongated in fruit: flowers bright yellow, 15^{mm} long, the wings exceeding the vexillum, but shorter than the keel: calyx-teeth triangular-subulate, shorter than the tube: pod two or three-jointed, smooth.—Near Helena, Montana, May, 1892, *F. D. Kelsey.* Nearest *H. borealis*

Nutt., but distinguished from it by its more erect habit, fewer and usually broader (prominently cuspidate) leaflets, much shorter and denser racemes of larger bright yellow flowers, and wings larger than the vexillum.

6. RUBUS DELICIOSUS James. — Mrs. S. B. Walker, of Castle Rock, Douglas County, Colorado, has sent a form of this species with glandular pubescence on branches, young leaves, and calyx, but not so prominent as in *R. Nutkanus* Moçino. It was collected June, 1889, at an elevation of $7{,}000^{ft}$. Mature fruit was not seen.

7. **Aster MacDougali,** n. sp.—Glandular throughout, minutely so below, densely so in the inflorescence and on the involucre: stems erect, 5 to 9^{dm} high, flexuous and corymbosely branched above or simple, soon becoming naked below, from a slender creeping rootstock: leaves oblong-ovate, acuminate, strictly sessile by a round or cordate base, thin, prominently nerved, coarsely and sharply dentate, scabrous on the margins, 8 to 13^{cm} long, 3 to 6^{cm} broad: heads few on each branch (13^{mm} high, 15 to 20^{mm} broad), terminating the densely glandular peduncles (2.5 to 4^{cm} long): involucre rather loosely imbricated in three or four series, the bracts narrowly lanceolate from a broad base, acute or acuminate, light-green with a glandular-ciliate and narrow scarious margin: rays twenty-five to thirty, pale blue, linear, 2^{cm} long: style appendages flat and broad (linear in the ray-flowers): stamens very acute: achenes linear-oblong, 6 to 10 nerved, villous, with simple very coarse densely bearded pappus.—Near Lake Pend d'Oreille, Idaho, August, 1892, at an elevation of about $3{,}000^{ft}$, *D. T. MacDougal.* A very handsome species, near *A. acuminatus* Michx. in general appearance, but differs in being glandular pubescent throughout, in its sessile leaves with rounded or subcordate base, larger heads, more foliaceous lanceolate involucral bracts not so loosely imbricated, longer pale blue rays, flat and broader style-appendages, and much longer and villous (not glandular) achenes.

8. DODECATHEON CRENATUM Greene.—We refer here a Dodecatheon collected at Granite, Montana, July, 1892, at an altitude of $8{,}500^{ft}$ by *F. D. Kelsey.* The specimens are without fruit, and differ from the description of *D. crenatum* only in the leaves being entire or nearly so, and in the umbel being fewer-flowered. Mr. Kelsey says that the "flowers

when fresh appear coarse, large and showy." Possibly mature fruit will indicate greater differences.

9. MERTENSIA LANCEOLATA DC.—A low white-flowered form, with narrow sharply acute leaves, and filaments broader and longer than usual (almost twice as long as the short greenish anthers) has been collected by *Mrs. S. B. Walker* near Castle Rock, Douglas county, Colorado, 1892. The form would seem to deserve varietal rank in a less polymorphous species.

10. MIMULUS LEWISII Pursh, var. **exsertus,** n. var.—A tall form, with broader leaves (6 to 9^{cm} long, 2.5 to 3.2^{cm} wide) which are acuminate and perfectly entire, corolla 4.5^{cm} long with the broad tube about half exserted (limb reddish-purple and tube lighter colored), and the whole plant more or less viscid pubescent.—High mountains of northern Colorado, *George E. Osterhout* of New Windsor, Colorado.

11. **Pentstemon linearifolius,** n. sp.—Near *P. Lyalli* Gray, but grayish throughout with soft white pubescence: stems erect, about 3^{dm} high, from a very long horizontal slender woody rootstock: leaves smaller, linear (sometimes narrowly lanceolate), entire (rarely a very few indistinct serrulations), 4 to 5^{cm} long: raceme six to twelve-flowered, more glandular: flowers much smaller (2.5 to 3^{cm} long), light purple: anthers less woolly: pod oblong-ovate, very acute, 15^{mm} long, longer than the narrowly lanceolate attenuate sepals.—Near Lake Pend d'Oreille, Idaho, 1892, at an elevation of $3,000^{ft}$, *D. T. MacDougal.*

12. PENSTEMON HUMILIS Nutt.—A form with longer peduncles and pedicels than usual, making a longer and laxer inflorescence, was collected by *Mrs. S. B. Walker* in Douglass County, Colorado, May, 1892, at an elevation of $7,500^{ft}$.

13. PENTSTEMON CONFERTUS Dougl., var. CÆRULEO-PURPUREUS Gray.—A form with long peduncles bearing fewer flowers and so forming a much looser raceme, and with leaves almost uniformly denticulate, was collected near Helena, Montana, June, 1891, by *F. D. Kelsey.*

14. **Pentstemon ellipticus,** n. sp.—Erect stems herbaceous, minutely puberulent, 7.5 to 12.5^{cm} high, arising as branches from a more or less horizontal (apparently subterranean) woody stem: leaves firm but hardly coriaceous, broadly elliptical to nearly rotund, obtuse, 2 to 3^{cm} long,

1.5 to 1.8cm broad, sessile, those on the sterile branches short-petioled and longer, distantly serrulate or entire, densely and minutely black-punctate beneath: the slender pedicels, leaf-like bracts, and sepals of the three or four-flowered racemes densely viscid pubescent: corolla violet-purple, 3.5cm long, strongly bilabiate and ventricose, with narrow throat and erose lobes: sepals lanceolate, more or less attenuate, 10 to 12mm long: stamens somewhat exserted, deep purple, with white comose anthers, the sterile one shorter and densely pubescent above: pod oblong-ovate, acute.—Near Lake Pend d'Oreille, Idaho, August, 1892, at an elevation of 3,000ft, *D. T. MacDougal.* A member of the puzzling *P. Menziesii* group, which has been variously modified by Dr. Gray and Professor Greene. Our plant seems to bear some relationship in habit and general structure to the dwarf alpine *P. Davidsonii* Greene, but, of course, is very much larger in every way, the erect herbaceous leafy flowering branches rising 7.5 to 12.5cm above the ground from a more or less procumbent or horizontal woody subterranean stem.

15. PLANTAGO PATAGONICA Jacq., var. **lanatifolia,** n. var. —Nearest to var. *gnaphalioides* Gray, but distinguished by its more spreading habit, floccose throughout with long silky white wool, more numerous (thirteen to twenty-one) oblanceolate broader (10 to 18mm) usually five to seven-nerved somewhat minutely denticulate leaves, more numerous peduncles, thicker spikes (6 to 12mm in diameter), and bracts but two-thirds the length of the sepals.—Texas, Hockley (*F. W. Thurow* in 1890), Industry (*H. Wurzlow* in 1891). This description includes two forms, one of which is very densely white floccose, with narrower and more numerous spikes and very acute leaves; the other more robust and spreading, with broader and scarcely acute leaves.

Herbarium Lake Forest University, Lake Forest, Ills.

Some recent investigations on the evaporation of water from plants.[1]

ALBERT F. WOODS.

At the meeting of the American Association for the Advancement of Science in August, 1891, a paper was read by Prof. Bessey and myself on "Transpiration; or, the loss of water from plants." In that paper we gave in a very condensed way the condition of this problem at that time.

We called particular attention to two papers by Dr. Alfred Burgerstein, published in 1887 and 1889, and called "Materials for a monograph relating to the phenomena of transpiration of plants."[2] Dr. Burgerstein's papers make a most valuable contribution to the literature of transpiration, and are invaluable to one who desires to make a critical study of the subject.

A pamphlet by Dr. Oscar Eberdt[3] is also a masterly presentation of the subject, and contains the record of many valuable experiments.

The investigations recently carried on by M. Henri Jumelle and published in the Revue générale de Botanique, have afforded us a clearer insight into the relation existing between evaporation and assimilation. M. Jumelle shows[4] that a ray of light, passing through the chlorophyll of a leaf, is partly used in assimilation and partly in chlorovaporization. If the supply of carbon dioxide is taken away from the plant, assimilation is, of course, stopped, and more of the energy of the absorbed light ray is left free to affect chlorovaporization.

In a series of experiments which I conducted on the internal temperature of plants, I found that a ray of light, after passing two parallel panes of clear glass three-fourths of an inch apart, filled between with a saturated solution of alum in distilled water, had a remarkable calorific effect on plant tissue rich in chlorophyll, quickly raising the internal temperature from 3° to 5°C. higher than the air. Direct light (that is,

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[1] Read before the Botanical Seminar of the University of Nebraska, April 15, 1893.

[2] Materialien zu einer Monographie betreffend die Erscheinungen der Transpiration der Pflanzen. Verh. K. K. Zool.-Bot. Gesells. Wien.

[3] Die Transpiration der Pflanzen und ihre Abhängigkeit von äusseren Bedingungen. Marburg 1889.

[4] l. c. 1889, no. 1.

light not passed through glass or alum solution) had a much greater effect. In some cases, as in the petiole of the banana leaf in direct sunlight, the temperature was 20°C. higher than the air. The temperature decreases as the intensity of the light.

Green tissue warms much more rapidly than it cools. Living green tissue of cactus and castor-oil plant warms more rapidly than dead tissue of the same, but cools at about the same rate. The dead tissue follows very closely the temperature fluctuations of an equal bulk of water enclosed in a smoked glass cylinder. Checking evaporation causes a rise of temperature proportional to the decrease of evaporation.

The investigations that I made last year on the evolution of bubbles of gas by green plants, in water, exposed to light,[5] showed conclusively that this evolution of bubbles, from such plants as *Myriophyllum*, was not the result of assimilation, but the calorific effect of the absorbed light ray.

These few facts, taken from my reports presented to the Seminar last year, are certainly, as far as they go, confirmatory of M. Jumelle's results.

M. Jumelle's next work was on the influence of anæsthetics on the transpiration of plants. His apparatus was simple, consisting of a bell glass set in a dish of mercury. The openings through the top of the bell glass for the introduction of anæsthetic and carbon dioxide were under absolute control. The plant experimented with was placed under the bell glass and the water evaporated collected by calcium chloride. In the experiments on chlorophyllian transpiration in the presence and absence of carbon dioxide, the loss of weight of the plant was noted, as well as the gain in weight of the calcium chloride. But in the experiments with anæsthetics he considered that the loss of weight of the plant would not exactly represent the amount of water evaporated because of the weight of the ether absorbed by the anæsthetized leaves. In all cases M. Jumelle first determined the amount of anæsthetic necessary to stop assimilation without killing the plant. At the close of the experiment the plant was washed in water, after which, if the experiment had been successful, assimilation started again. The results of these investigations showed that in the light the effect of the anæsthetic was

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[5]**Extract published in Publication II of the Nebraska Academy of Sciences, 1892.**

to increase transpiration. This Jumelle considered to be due to the fact that the anæsthetic, by affecting the chloroplast, stopped assimilation; thus more of the energy of the absorbed light ray was used in chlorovaporization. In the dark M. Jumelle found that the anæsthetized plant lost less water than the normal plant, but failed to come to any definite decision as to why this should be so.

MM. Verschaffelt[6] criticised M. Jumelle's methods of experimenting, and questioned his conclusions in regard to the relation of carbon dioxide to evaporation in the light and in the dark. They used in their investigations a modification of the Kohl transpiration apparatus. The modification consisted simply of a glass vessel containing culture fluid or water into which the roots, or in some cases the cut end, of the plant extended. The evaporation was measured by the loss of weight of the apparatus; of course no water could escape except through the plant. In the case of assimilating plants the water evaporated was collected by calcium chloride. This was because the Verschaffelt brothers considered that the increase in weight of the plant due to assimilation must be taken into account. They concluded that the transpiration of a plant in an atmosphere free from carbon dioxide is greater than in air containing it, both in the light and in the dark. Further, that the presence of carbon dioxide in the air decreases evaporation in the light independently of assimilation.

M. Jumelle made a critical discussion of the MM. Verschaffelt brothers' investigations and conclusions.[7] He went over his experiments with apparatus meeting all their objections and not only proved the correctness of his own former results but also showed where the MM. Verschaffelt made their mistake.

This article is followed by a final one[8] giving the results of further investigation of the points in controversy which results fully confirmed Jumelle's former conclusions, namely, that, in the light, the presence of carbonic acid gas in the air around the plant devoid of chlorophyll has no effect on transpiration. The influence of carbonic acid gas is exerted exclusively upon chlorophyllian transpiration.

The absence of carbonic acid gas from air supplied to green

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[6] Bot. Centralb. XLII (1890). 373-374.
[7] Revue gén. de Bot. 1891. nos. 30 and 31.
[8] Revue gén. de Bot. Juillet 1891.

plants in light causes an increase in transpiration. This may be explained by the fact that the energy of the light rays absorbed by the chlorophyll, which energy is ordinarily partly used in assimilation, is here wholly free to effect transpiration.

In the BOTANICAL GAZETTE for February, 1893, is an article by Albert Schneider on the "Influence of anæsthetics on plant transpiration." In this article Mr. Schneider attempts to show how M. Jumelle came to erroneous conclusions. Quoting from Mr. Schneider's article: "Jumelle has lately been carrying on a controversy with Verschaffelt who maintains that ether increases transpiration in the dark as well as in the light. This Jumelle has attempted to disprove in his final paper on anæsthetized plants."

Mr. Schneider has evidently been a little careless in his reading or else has failed to indicate where he received his information. The only controversy, so far as I know, between M. Jumelle and MM. Verschaffelt has been on the relation of carbon dioxide to transpiration in the light and in the dark as before mentioned in this paper. M. Jumelle's final article (l. c.) has nothing in particular to say in regard to anæsthetized plants but deals wholly with the problem under discussion between himself and MM. Verschaffelt. Further Mr. Schneider says: "By way of criticism it must be pointed out that, in the first place, Jumelle as well as Verschaffelt used only portions of plants in their experiments and hence their conclusions are of little practical value." This criticism might be justly made had these investigators used, for the measure of evaporation, as did Mr. Schneider, the amount of water absorbed by the roots. When the loss of water is measured as they measured it, the results obtained from branches, properly prepared and supplied with water, are just as trustworthy as the results obtained from whole plants. M. Jumelle in his first reply to MM. Verschaffelt says distinctly that he used *entire* plants in order to exactly meet the conditions of the experiments performed by MM. Verschaffelt. Later however both investigators used branches as well as whole plants.

Turning now to Part III of Mr. Schneider's article, "Experiments on transpiration of entire plants"; first of all he has made a very great mistake in assuming that the amount of water absorbed by the roots of a plant represents the amount "transpired." By consulting Dr. Oscar Eberdt's inves-

tigations in the article mentioned in the first page of this paper it will be seen that this relation, even under the most favorable conditions is far too general and fluctuating to be of any value whatever as an exact measure of evaporation.[9] This difficulty alone is sufficient to make Mr. Schneider's results practically valueless as far as transpiration is concerned.

Further, M. Jumelle took special pains to ascertain the amount of anæsthetic that was required to stop assimilation *without killing the plant*, and always tested the plant after the experiment in order to be certain that it had not been killed. Mr. Schneider took no such precaution in his experiments, but says that he took "no special notice of the amount of anæsthetic used;" and further says that after a time the plants exposed were killed. He is thus dealing with plants under entirely different conditions from those maintained by M. Jumelle; hence, even had Mr. Schneider's measure of transpiration been reliable, his results could have no direct bearing on M. Jumelle's results or conclusions.

In part IV, "Experiments on transpiration of leaflets," Mr. Schneider estimates the transpiration by weighing the leaflets and noting the loss. The slight objection to this I have before mentioned and will let it pass. The second objection is that the leaflets were not supplied with water and the amount of anæsthetic supplied was too great to meet the conditions of Jumelle's experiments. The fact that the leaves were not supplied with water is alone sufficient to make the results at least extremely doubtful. It is unnecessary to discuss Mr. Schneider's article further at this time. It is certainly quite evident that his results do not affect M. Jumelle's conclusions.

Coming back now to the condition of the problem of "transpiration" as left by M. Jumelle. First, the presence or absence of the usual amount of carbon dioxide in the air has no effect on the transpiration of chlorophyll-less plants either in light or dark. Here certainly "transpiration" has no relation to assimilation. We know further that etiolated plants lose water much more rapidly in strong light than in the dark.

Plant.	*Darkness.*	*Diffused light.*	*Sunlight.*
[10]Zea Mais (etiolated). . . .	106	112	290^{mgr}
Zea Mais (green)	97	114	785^{mgr}

[9]See also Dr. Alfred Burgerstein's remarks on this subject page 67, part 2, of article referred to on first page of this paper. Also paragraph 748 on page 279 of Goodale's Phys. Bot.—Also Vines' Phys. Bot. page 99.

[10]Experiments by Wiesner, page 110, Vines' Phys. Bot.

Here again it is evident that "transpiration" is independent of assimilation. The greater loss from the green maize plant in light as compared with the etiolated one Wiesner refers to the fact that the rays of light absorbed by the chlorophyll of the green plant are converted into heat, a conversion which is not effected to the same extent by the etolin of the etiolated plant. If we now stop assimilation by any means the 785^{mgr} lost in the sunlight from the green Zea mais would, according to M. Jumelle, be increased, showing again that transpiration does not increase directly with assimilative activity in the protoplasm, but, on the other hand, decreases as assimilative activity increases. It is also known that as the vitality of the protoplasm decreases it loses its power of retaining water. We are justified, then, in maintaining that the excess of the loss of water in the light over the loss in the dark, both in green and etiolated plants, is due to the calorific effect of the light and is therefore purely a physical process, *evaporation.*

Now in regard to the relation of anæsthetics to "transpiration" in the dark. M. Jumelle's results show that the anæsthetized plant loses less water in the dark than the normal plant. This fact M. Jumelle says he can not satisfactorily explain. These results so far as I know have not been questioned but rather confirmed by other observers. I think, however, that all have made errors in conclusion on this point which I shall endeavor to correct. The influence of an anæsthetic on protoplasm in the dark is more marked than the influence of the same dose in the light. One would conclude from the data at hand that anæsthetized protoplasm has less power than normal protoplasm of resisting evaporation. We would expect the anæsthetized plant to lose more water in the dark than the normal plant.

In an investigation that I made, recently, on the relation of sulphuric ether to the opening and closing of stomata, I found that, even in moderately strong diffused light, a strong dose of ether nearly closed the stomata. In weak diffused light the action was very marked, especially so in the leaf of *Canna Indica* in which the stomata closed almost instantly when brought under the influence of ether. These experiments were repeated many times with essentially the same results. If, as these experiments indicate, the stomata of anæsthetized plants remain closed in the dark, we could readily understand why

the water-loss should be less. In order to avoid this difficulty (and another possible one, viz., the taking of water from the outer exposed cells of a plant in air containing ether, by the inner less exposed ones), I used moss plants (*Mnium sp.*) set in small metal pots. The leaves were large and composed of a single layer of thin walled cells. I first determined the maximum dose of ether that might be administered to a plant without causing death. The plants were put under the influence of ether, then removed to ordinary air, and the evaporation compared with that of normal plants. In strong diffused light and sunlight the leaves of the anæsthetized plant dried and curled rapidly while the normal plant was much more slowly and less affected. In weak diffused light the anæsthetized plants lost water most rapidly as shown by the drying and curling of the leaves while the normal plants were only slightly affected. In the dark the same results were obtained as in weak diffused light. The drying of the plant is most rapid if it is first put under the influence of ether, then removed to dry air containing only a small amount of ether. After the experiments the anæsthetized plants were washed in water and fully regained their former freshness, showing that the investigations had been made on living subjects.

The results of my experiments indicate that the effect of ether on the exposed plant cell, in the dark as well as in the light, is to decrease its power of retaining water and thus increase the supply for evaporation. In the dark as well as in the light evaporation increases as the activity or vitality of the protoplasm decreases. We have good reason to believe that "transpiration" would be nothing in a perfectly saturated atmosphere if it were possible to obtain such, and that it is nothing in all wholly aquatic plants. It is evident, therefore, that so-called "transpiration" is not something which protoplasm *does* but something which it *resists*. It is not a physiological function or activity of protoplasm although it may have a physiological relation to the normal development of certain plants or parts of plants. Transpiration is nothing more than *evaporation*.

University of Nebraska, Lincoln.

Noteworthy anatomical and physiological researches.

The plant and its relation to iron.

The recent investigations by Professor Molisch[1], given a "mention honorable" by the Paris Academy, is one of the landmarks in physiology. As, however, the student of vegetable physiology will read the paper, we shall give only the main results. The first part of the book deals with iron-reagents in general, and here the author gives a new reagent which he describes in these words: "Die meisten organischen Verbindungen, welche Eisen in maskirter Form[2] enthalten, lassen selbst in ganz ausserordentlich geringen Mengen ihr Eisen erkennen, wofern man die betreffenden Objecte ein oder mehrere Tage oder Wochen in gesättigter wässeriger Kalilauge liegen lässt und dann nach raschem Auswaschen in reinem Wasser den gewöhnlichen Eisenreactionen, am besten der Ferrocyankaliumprobe, unterwirft." This method was[3], however, on the suggestion of Arth. Meyer[4], afterwards revised and it was found that the potassium hydrate would contain minute quantities of iron which the globoids of the aleurone grains, or other parts of the cells, can take hold of and hoard. This was the case, even when the reagent was selected as "chemically pure." Therefore, this part of the book must be used cautiously. Having then traced the iron in a great many plants throughout the vegetable world, the author proceeds to show the distribution of the substance within the cell-organism, in the various organs.

Among the algae, iron was found in *Cladophora aegropila* Rabenhorst, the membrane of which is, to some extent, covered with a yellow or red layer of this substance, the cell-wall being also more or less impregnated therewith. In *Peyssonnelia squamaria* Dne., *Valonia utricularis* Ag., and in *Oedogonium*, an incrustation of similar appearance is also observed, while in *Mesocarpus*, *Spirogyra*, and certain diatoms, iron was found also in the cell-contents, penetrating the nucleus and the chlorophyl-band. Among the fungi, *Rhizomorpha fusca*, and among the lichens, the so-called "oxidized lichens" (*Lecidea declinans* Nyl., and other species) displayed a con-

[1]Die Pflanze in ihren Beziehungen zum Eisen. Jena. 1892. 3 Marks.
[2]I. e., in organic combination.
[3]Berichte der Deutschen Botanischen Gesellschaft. XI (1893) 73-75.
[4]Flora, 1892, Ergänzungsband p. 291.

siderable incrustation of iron. Among the mosses, *Fontinalis antipyretica* L. gave a very intense reaction, but only in the walls; the cell-contents never gave evidence of any amount of iron being present. In the procambium of the cotyledons of *Sinapis alba*, the author had a well marked reaction; during the first or second week of germination the iron disappears entirely.

Following this is a very important series of investigations on the "iron-bacteria:" *Crenothrix Kühniana* Rabenh.[5], *Crenothrix dichotoma* Cohn, and *Leptothrix ochracea* Kütz., previously studied by Cohn[6], Zopf[7], and Hugo de Vries[8] with regard to their iron-hoarding properties, and first noticed in this connection by Winogradsky;[9] Molisch finds that the iron even after its oxidation in the "Gallerthülle" of these algæ, never enters into their protoplasm. The outer slimy layer has a very singular attraction for the iron contained in the nutritive solution which there becomes oxidized. But the other parts of these plants have no specific oxidizing power.

By means of his reagent mentioned above, the author further showed that the chlorophyl-molecule contains *no* iron. Studies on chlorosis showed that deficiency of iron in the protoplasm of any plant which may be subject to chlorosis causes a general pathologic state of the plant, and that the condition named is only one feature thereof.

Fifty-five species of fungi gave iron-reaction. This, in connection with experiments in nutritive media, led to the result that at least for *Aspergillus niger* iron is indispensable, and that this substance seems to play a very important role in the life of many other fungi.—J. CHRISTIAN BAY.

Latent irritability.

Sachs[10], referring to his very extensive studies of root-geotropism, calls attention to a special side of root-life of tropical and other epiphytes, namely to the fact that certain root-hairs are not geotropic, but follow other laws in growing out

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[5] =Cl. polyspora Cohn.

[6] Cohn's Beiträge I. 108.

[7] Entwicklungsgeschichtliche Untersuchung über *Crenothrix polyspora*. Berlin, 1879.

[8] Die Pflanzen und Thiere in den dunklen Räumen der Rotterdamer Wasserleitung. Jena, 1890.

[9] Ueber Eisenbacterien. Botanische Zeitung. 1888, p. 261.

[10] Physiologische Notizen. V. Ueber latente Reizbarkeiten. (Flora, LVII (1893). 1–15.

among the earth-particles. Experiments on the growth of the roots of *Solanum tuberosum* showed how the root-system of this plant, when the surroundings are arranged similar to those of an epiphytic vegetation develops in a way like that of a genuine epiphyte. The property of doing so is, as long as the roots live under ordinary circumstances, latent, the adaptation to surroundings giving rise to this new feature of root-life. The facts thus obtained are used by Sachs to explain saltatory biological variations, one of the features of the "struggle for existence." Those who explain each and every property in an organism by the proper selection of species forget that we had the properties, irritabilities, and energies of the organs *before* the selection, or, at least, we ought to search for them. What we understand as the original properties of the organized matter, is not told by anybody, but Sachs is sure, "that certain properties, irritabilities, etc., were originally present, on which the struggle for life, and the natural selection could exert its influence."

It is very interesting to see how Sachs, in the autumn of his life, holds up again experimental physiology before a school of biologists which too often makes deductions concerning general biological laws, adaptations, etc., from facts just as they find them and which does not trace these facts to their origin by means of experiment.—J. CHRISTIAN BAY.

Studies upon the Xyrideæ.

How incomplete our present knowledge is of this family is only too manifest when we examine the literature upon this subject. It seems as if the majority of authors have restricted themselves to mere systematic treatises, as for instance Martius, Kunth, Seubert, Chapman, Grisebach and Ries, while anatomical studies are very few and scattered. The present paper[1] is, therefore, highly welcome, since the author gives us a number of details concerning the morphology and anatomy, besides describing and figuring several new and very interesting species.

The vegetative organs show morphological characters that are not only useful in the discrimination of species, but are also of great interest when considered from a comparative point of view. This is the case for instance with the ramifi-

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[1] NILSSON, ALBERT: Studien über die Xyrideen. Kgl. Svenska Vet. Akad. Hdlgr. xxiv. no. 14. pp. 75 pl. 6. Stockholm 1892.

cation of the axis. We have here three forms of shoots: (I) "vegetative-floral," where the leaf-bearing axis is terminated by the inflorescence; (II) "floral," the leaves of which are sheathing and bladeless; and (III) "vegetative," which bears leaves of normal shape, but where no inflorescence becomes developed, at least not in the first year.

The true "vegetative-floral" axis is the main stem itself, the "vegetative," on the contrary, representing a secondary axis. The "floral" shoot is also always secondary, and illustrates a biaxial ramification, such as is known from, for instance, a few species of *Carex*[2], and others of various families. The main-shoot is in these purely vegetative and develops continuously only leaves, from the axils of which the flowering stems become developed.

Most of the species of *Xyris* show the development of a "vegetative-floral" main-axis, while in others the main axis is merely "vegetative." *Xyris savannensis*, however, shows all three forms of shoots upon the same individual. The ramification becomes still more complicated, when two or even three shoots develop in the axil of each leaf; such shoots are either all "floral," or "floral" and "vegetative-floral."

The roots occur in the two forms "typical" and "mechanical," which are, mutually, very different in structure. The first of these show the same plan, with a few modifications which are characteristic of the respective species. Most interesting is the fact, already discovered by Van Tieghem[3], that the pericambium is interrupted by the protohadrome in certain species of *Xyris*. The "mechanical" roots, which were observed in *Abolboda brasiliensis* and some species of *Xyris*, have the central part composed of stereome, besides that the pericambium and the endodermis consist of very thick-walled cells.

The stem is mostly differentiated into an under-ground rhizome with sympodial ramification, and an above-ground, flower-bearing scape. *Xyris witsenioides* forms an exception by having a distinct stem above-ground, the length of

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[2]WYDLER: Ueber die Axenzahl der Gewächse. Botan. Zeitung 1844. See also: CALLME: Ueber zweigliedrige Sprossfolge bei den Arten der Gattung *Carex*. Berichte d. deutsch. bot. Gesells. v. heft 5.

[3]Van Tieghem: Structure de la racine et disposition des radicelles dans les Centrolepidées, Eriocaulées, Joncées, Mayacées et Xyridées. Journal de Botanique I. 305.

which may reach 30^{cm}. The anatomy of the lower part of this stem was, however, like that of a rhizome. The scape varies in outline from terete to triangular, and shows frequently a conspicuous furrowing. The cells of the mechanical tissue differ from typical stereome-cells by their length and having their pores transverse. This has hitherto only been observed in the *Restiaceae.*[4]

The leaves show also several variations. They are, in regard to the arrangement of the tissues, centric, excepting in *Abolboda brasiliensis*, where they are dorsiventral.

The author discusses also the geographical distribution of the various species. While the genus *Abolboda* is restricted to South America, *Xyris* has been recorded from all parts of the world excepting Europe. One hundred and eleven species are enumerated of *Xyris*, and seven of *Abolboda*. Twenty-one are described as new to science.

Among the species of *Xyris* which are enumerated in this paper, several have been named and described by the same author in a previous note, entitled: "Ueber die Afrikanischen Arten der Gattung *Xyris*[5]", to which we hereby take the opportunity to call attention.—THEO. HOLM.

BRIEFER ARTICLES.

Notes from Gull Lake Biological Station of the University of Minn.—ROOTHAIRS IN ELODEA CANADENSIS.—In the absence of my anatomical library and periodicals I cannot say whether the presence of root-hairs in *Elodea* has been made out or not. De Bary in his *Comparative Anatomy* (Eng. tran. p. 55, 1884) seems to except *Elodea* from the root-hair forming plants, saying, "If we disregard the root-hairs which, with very vew exceptions (*Elodea*, Lemna, Ophioglosseæ) are universally distributed," etc.; and Van Tieghem in his Traité de Botanique, I. 677, (1891), observes, "quelques plantes se montrent même dépourvues de poils radicaux, aussi bien si la racine est aquatique, comme dans l'elodée (*Elodea*)." While I do not yet know upon whose observation these statements are based, I can state that they must be corrected, for *Elodea Canadensis* growing in the outlet stream of Cullen lake, Cass

[4] MASTERS: Observations on the Morphology and Anatomy of the Genus *Restio*. Journ. Linn. Soc. VIII. (1865). Pl. XIV, fig. 1.

[5] Öfversigt af Kgl. Svenska Vet. Akad. Förhdlgr. Stockholm 1891. no. 3. pp. 149–157.

county, Minnesota, shows in some specimens a very abundant formation of root-hairs. Copious material has been secured and a full description will follow later, if it turns out upon further examination of recent literature that such description is necessary.

SHORE FORMATION OF EQUISETUM LIMOSUM.—In the upper Cullen lake, the third of the series and at the head of the chain, a most luxuriant growth of *Equisetum limosum* has been noted. This plant takes the place of *Scirpus lacustris* over large areas and produces a characteristic shore and bar formation. In some places it is the only plant growing over areas many acres in extent. It reaches out into five or six feet of water and fringes the shore to a depth of four or five rods or even more. Much of the plant is var. *polystachyum* Brückner, while the type is rather more abundant. Nothing like this has previously been met with during a rather extended experience among the lakes of Minnesota. Commonly the plant, while abundant enough, does not produce a solid formation but is scattered amid sedges, rushes and limnetic grasses. At upper Cullen lake it covers territory doubtless a square mile or more in extent, to the total exclusion of any other archegoniate and of all metasperms. This gives a peculiar and highly archaic aspect to the shores and bars of the lake in question.—CONWAY MACMILLAN.

EDITORIAL.

THE ANNOUNCEMENT of an International Botanical Congress in America has drawn out some adverse criticism, and has excited considerable apprehension regarding the success of the movement. It is more than three years since the GAZETTE suggested that such a congress be held. There has been no material change in the conditions as understood at that time and as existing now. The feeling of uncertainty regarding the wisdom of calling for a congress is largely based upon the strong probability that comparatively few of the prominent European botanists will find it convenient to attend, owing to the distance. No one is in a better position to appreciate this, and the other difficulties connected with the project, than the members of the committee. Yet it has seemed best in the face of various obstacles to issue a call for the congress.

THE TERM "congress" calls up very different concepts in the minds of different persons. As to the distribution of the membership, if as claimed by Otto Kuntze the conclusions of the Genoa congress were invalidated because it consisted of sixty Italians and forty foreigners,

and was therefore degraded from an international to a local congress, the Madison gathering bids fair to result even more disastrously, for one correspondent declares that it is "likely to be less than national, even and altogether provincial-American." The Genoa congress has also been assailed as lacking authority to act, because its members were not truly representative; *"er hat sich also Gesetzgebung angemasst."* The Madison Congress lays itself open to the same criticism. The opinion is also held that it is "outrageous to announce a program from which all original research is excluded," from which it may be inferred that any limitation of subjects whatever would find objectors.

THE SPACE at command does not permit a discussion of what an ideal congress might be, or even what the gathering at Madison might have been under other conditions and management; and all that can be attempted is to give a brief statement of what the Madison congress can reasonably be expected to accomplish under existing circumstances.

In the first place the Madison congress is at the close of a series of brilliant gatherings of American scientific societies extending over nearly two weeks. These societies are furnished with the necessary machinery for receiving, hearing and publishing papers, and will consider it an honor to accord visiting scientists from abroad the same privileges enjoyed by their own members. The visitor will find in these several audiences most appreciative and responsive listeners. By this fortunate circumstance the congress is enabled to exclude papers of research, as well as others which do not bear directly upon uniformity of usage, knowing that all interests will thus be even better subserved than could be done by any other method.

This arrangement also removes a most formidable difficulty as to time. The Genoa congress discussed but one small phase of the nomenclature question, less than was considered at the Rochester meeting, and heard but a few papers, and yet occupied a week. It would probably be impossible to keep the Madison congress together a week however interesting the program, following as it does such a long series of scientific gatherings. Yet it is desirable that the subjects considered should possess variety, as there are many botanists who "don't enjoy the prospect of being dosed with 'nomenclature'." To get variety with limited time and yet accomplish important results requires careful selection of topics.

THERE ARE QUESTIONS in various departments, many more than can be settled or even considered by a single congress, which demand attention from all those interested in the advancement of the respective

departments. In order that these questions may be suitable for the program of an international congress they should interest botanists, of whatever locality, or whatever language, and be genuinely debatable. Matters of fact do not call for discussion, but for investigation. Deductions, opinions, methods, usage and doctrines may be discussed. The class of questions most intimately affecting a large number of botanists, and which can be brought to a satisfactory solution easier and quicker by word of mouth than by pen are those relating to usage, and of these the nomenclature of classification is the most prominent, and should first receive attention.

To say that one is already tired of the seemingly interminable discussion of the nomenclature question is frivolous. It is a fundamentally important matter, and can only be settled by a better general understanding of the situation, and an authoritative agreement upon the chief points in debate. The sooner this is done the better for the whole science of botany, and of the allied fields of horticulture, etc. He who will not take hold of the work at hand because it is not the kind preferred, may be looked upon as a doubtful helper at any time.

BUT WHILE the so-called nomenclature question should be taken up by the congress, because most prominent and most urgent, there is no reason, and no disposition so far as we know, to exclude other questions suitable to the occasion. If any one has a topic in mind which he thinks appropriate for such a gathering, he should communicate it to some member of the committee. Whoever has nothing to offer, however, would do well to bear in mind that it is unqestionably bad taste for him who does not work to criticise him who does.

THE OPPONENTS of the congress are undoubtedly right in saying that a congress which does not uniformly represent the several botanical interests in various parts of the world, can not properly assume to exercise the full powers of legislation. But the questions upon which a well constituted congress are to pass can not be settled by a single discussion, and gatherings like that to be held at Madison, even if imperfectly representative, will greatly hasten a better general understanding and lead up to the final decision. It is a case of doing what one can and working toward the desired goal, rather than waiting idly for the ideal opportunity.

THERE IS STILL another reason why a congress should be held at this time. America needs to be botanically discovered by Europeans. The country has botanical wealth; a little crude, it may be, when compared with foreign riches, but still there is wealth, and it has yet barely come to the notice of most foreigners. What better time could there be, than when all the world is looking toward Chicago, to direct

the attention of the botanists of the world toward botanical activity in America? If the present congress does not prove all that its well wishers could desire, it may yet be the means of eventually securing upon American soil the truly representative international congress to which all will be willing to concede authority.

CURRENT LITERATURE.

A guide to wild flowers.

A short cut is always in order. Very frequently, however, one needs to be well posted in the geography of a country before a short cut is safe. It seems to us so with the book before us.[1]

Mrs. Dana endeavors to make a book which shall enable one to name plants which he is able to find without using "some key which positively bristles with technical terms and outlandish titles," and this because "their names alone serve as a clue to their entire histories." She has selected about 400 of the most conspicuous flowering plants of the northern United States, omitting the commonest and best known, as well as those with inconspicuous flowers, or those which are rare or introduced as escapes from gardens. Illustrations of very decided artistic excellence and accuracy are used freely. Ninety-seven of the 104 full page plates are original. Those species which are of the greatest beauty, interest, or frequency, have been selected for these drawings.

The plants are arranged in accordance with their colors and the season of blossoming. White, yellow, pink, red, blue and purple, and "miscellaneous" are the six main groups. It would seem however that some further subheads than these would have been exceedingly convenient. The descriptions of the plants with white blossoms cover nearly 100 pages, and one has to look over a considerable number of these in order to find any plant which he may have in hand. Nearly half of the white flowers enumerated belong to distinctively spring plants, and forty pages is rather a large area through which to look for the names. In our judgment the book would have been greatly improved had the author introduced some simple artificial keys which would have guided one in the path in which he is now left to grope.

[1] Dana, Mrs. William Starr:—How to know the wild flowers: a guide to the names, haunts, and habits of our common wild flowers. Illustrated by Marion Satterlee. Third edition. 12mo. pp. xvi + 298. pl. 104. New York: Chas. Scribner's Sons. 1893.

The book will be for amateurs a useful supplement to Gray's Manual, but it is doubtful if they will reach certainty with this book so readily as with that. The difference in the number of technical terms which it is necessary to know in order to use the two books is not so great as appears at first sight.

A reader in botany.[1]

The second part of Miss Newell's Reader in Botany is as admirable in its selections and in the topics chosen as has been her other botanical work. The articles are taken from such authors as Darwin, Sprengel, Kerner von Marilaun, Wallace, Gray, Grant Allen, Lubbock, Halsted, and Mrs. Buckley. Several of the chapters are original with the author, and one on the common dandelion has been written for the reader by Mr. F. Le Roy Sargent. The topics chosen are well calculated to stimulate interest in the minds of young students, and they are all directed toward the interesting and attractive phases of plant life. Here are some of the subjects:—cross fertilization; protection of pollen; attractive and protective colors of fruits; weeds; how seeds travel; habits of insects in relation to flowers; epochs in the history of botany.

If such books were more often seen in high schools, and students were taught thus to observe the habits of plants, we should hear less complaint from students that they never did like botany, and we should have less popular misconception of what botany really is.

Minor Notices.

DR. B. L. ROBINSON has published his present views of certain caryophyllaceous groups[2], views that are of special interest as they have to do with the forthcoming part of the Synoptical Flora. The closely allied genera Silene, Lychnis, and Agrostemma are kept apart on the old lines. Silene is credited with fifty species, seven of which are introduced, and one is new, another being transferred from Lychnis. Several new varieties are made, S. Douglasii being especially favored. Lychnis also contains a new species. Otherwise, the author has given a very conservative presentation of a group in which there are several vexed questions as to generic delimitations. In this connection attention may be called to the suggestion of Mr. Frederic N. Williams[3] as to

[1] NEWELL, JANE H.:—A reader in botany. Part 2, Flower and fruit. Selected and adapted from well known authors. 12mo, pp. vi+179. figs. 36. Boston: Ginn & Co. 1893.

[2] ROBINSON, B. L.:—The North American Sileneæ and Polycarpeæ. Proc. Amer. Acad. XXVIII. 124–155. [June 22, 1893.]

[3] WILLIAMS, FREDERIC N.:—The disintegration of Lychnis. Journal of Botany, XXXI. (1893). 167.

the rearrangement of generic lines. Taking the species represented by Silene, Lychnis, and Agrostemma, he finds that there are two primary subdivisions based on whether the capsule is truly unilocular or has remains of dissepiments at base. The latter will include most species of Silene, and exclude S. noctiflora and S. Virginica, for which (with some species of Lychnis) Röhling's genus Melandryum stands waiting. Further subdivisions are suggested, which are summarized in a table presenting no fewer than nine genera. This is surely at the other extreme from the view which would consider that all three allied species should be merged into one group. The nine genera suggested by Mr. Williams are Agrostemma, Lychnis (very much restricted), Coronaria (a Linnean genus revived to contain certain species usually referred to Lychnis), Petrocoptis (a genus founded by A. Braun to further circumscribe Lychnis), Heliosperma (a genus of Reichenbach founded for the same purpose), and Melandryum, all of which belong to the Lychnis-group of unilocular capsules. The proposed genera of the Silene-group are Vicaria of Röhling, Eudianthe of Reichenbach and Silene.

Dr. Roland Thaxter has just published a fourth contribution on the Laboulbeniaceæ[1]. These papers are but preliminary to an illustrated monograph of the group. The present paper is based upon material collected during the past year in Maine and Massachusetts and also from the collections of Coleoptera in the Museum of Comparative Zoology in Cambridge. The result is astonishing, for the known species are doubled and seven new genera are proposed, and this together with the great modifications in forms noticed, indicates the existence of a very large and varied group. In two of the new genera the sexes are found separated upon distinct individuals. The appendages peculiar to the group, and heretofore called "pseudoparaphyses," are now recognized as sexual and are designated as "antheridial appendages." Of the fifty-two new species described in this paper, twenty are referred to the genus Laboulbenia, five each to Acanthomyces and Ceratomyces, two each to Heimatomyces and Corethromyces, and one each to Cantharomyces and Peyritschiella; while the remaining forms are included under new genera as follows: Haplomyces, having three species; Rhadinomyces and Amorphomyces, each with two species; Dichomyces, Chætomyces, Idiomyces, and Dimorphomyces, each including a single species.

Miss Alice Eastwood has published a list[2] of plants growing

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[1]Thaxter, Roland:—New species of Laboulbeniaceæ from various localities. Proc. Amer. Acad. xxviii. 156-188. [May 10, 1893.]

[2]Eastwood, Alice:—A popular flora of Denver, Colorado. Zoe Publishing Co. San Francisco. [No date.]

about Denver. It is meant to be something more than a list, for it contains more or less of popular description, but in the absence of analytical keys it can hardly aid the beginner in discovering the names of plants. It can be used as a useful check-list by the local botanist, and gives more or less information to the general botanist concerning the Denver flora.

DR. ALFRED C. STOKES has prepared a set of analytical keys[1] for the "fresh-water algæ and Desmidieæ of the United States." In his introduction he makes a strong plea for "analytical keys," claiming that the ability to readily discover the name of an object will often attract the beginner to further study. These keys, founded upon Rev. Francis Wolle's works, will probably enable amateurs to discover the names of the fresh-water algæ readily enough. There is no question that such handy keys of groups stimulate their study.

A HEAVY PAMPHLET from the division of vegetable pathology of the U. S. Department of Agriculture forms bulletin no. 4, and is devoted to the work of Dr. Erwin F. Smith upon peach yellows. This bulletin gives the experiments and conclusions of four years' work in testing the value of commercial and other fertilizers for the prevention and cure of yellows. In some parts of the country this method has been much relied upon, having been supported by very good scientific authority. The extended and careful labors of Dr. Smith, however, show it to be worthless. The experiments upon which this conclusion is based have been very thorough and form an admirable continuation of Dr. Smith's previous researches upon yellows.

DR. L. M. UNDERWOOD has published in the Memoirs of the Torrey Botanical Club an index of the literature of the Hepaticæ. The purpose of this index is "to present an author catalogue of the publications relating to this group, supplemented by a topical index for the purpose of more ready reference." It is to be completed by "an index of all species described, with references to each of the genera recognized at the present time, and a classified arrangement of the species to show our present knowledge of their geographic distribution." It is needless to say that the work will be exceedingly useful to all students of the Hepaticæ. The present part forms the first ninety-one pages of the fourth volume of the Memoirs.

THE REPORT of the Division of Vegetable Pathology of the U. S. Dep't of Agriculture for 1892, by the chief, Mr. B. T. Galloway, deals

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[1] STOKES, DR. ALFRED C.:—Analytical Keys to the genera and species of the fresh water algæ and the Desmidieæ of the United States. pp. 117. One plate. Edward F. Bigelow, Publisher. Portland, Conn. 1893.

with the work which has been carried on during the year upon grain rust, leaf blight of pear and cherry, black rot of the grape, gun-shot disease and rust of almond and prune, peach yellows and rosette, pear blight, and other diseases of cultivated plants. The results are of great economic value. Attention is called to the urgent necessity of giving more attention to questions of physiology in connection with pathological investigations.

AN AID TO THE STUDY of the plants of Queensland has been issued from the government press at Brisbane, for free distribution, prepared by F. M. Bailey, F. L. S., colonial botanist.[1] It embraces some account of the morphology and physiology of flowering plants, an extended glossary of botanical terms, and the characters of seven of the most important orders of Australian plants, i. e., Leguminosæ, Myrtaceæ, Rubiaceæ, Compositæ, Proteaceæ, Euphorbiaceæ, and Gramineæ, together with the characters of all the tribes and of one genus and species under each order.

PART SEVEN of the first volume of Contributions from the National Herbarium is devoted to a systematic and alphabetic index to new species of North American phanerogams and pteridophytes published in 1892. It is compiled by Miss Josephine A. Clark of the Herbarium Library. It is accompanied by a supplement to the index for 1891 covering several pages, including chiefly some plants from Costa Rica, which were overlooked in the publication of the preceding year.

AN INTERESTING pamphlet of thirty-seven pages, by Dr. W. J. Beal, has recently been distributed. It contains (1) the report of Dr. Beal as professor of botany in the Michigan Agricultural College, for the year ending June 30, 1892, (2) a chronological history of the botanical department of the college, and (3) a full report of the exercises at the laying of the corner stone of the new botanical laboratory.

THE ELEVENTH part of Husnot's Muscologia Gallica has just been issued. It deals with several of the genera which have been heretofore in this country reckoned as sub-genera of Hypnum. Ten plates accompany the part. The work evidently draws near its close, and maintains its high standard.

A REPORT ON THE SISAL HEMP of Florida, and other fiber-producing agaves, has been prepared by Chas. R. Dodge, of the U. S. Department of Agriculture. It is well illustrated and contains much interesting information.

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[1] BAILEY, F. M.:—A companion for the Queensland student of plant life. pp. 108. 8vo. Brisbane, Government Printer; 1893.

[2] DODGE, C. R.:—A report on the leaf fibers of the United States. Rep. no. 5 on Fiber Investigations. Dept. of Agriculture. pp. 73. 8vo. 10 plates and 12 figs. in text. Washington; Gov't. Printing Office. 1893.

OPEN LETTERS.

A suggestion.

Although the "Botanical Society of America" is still only a society "*in spe*", our confrére Dr. Britton has already (June number of the Torrey *Bulletin*) suggested a publication which he thinks the society might issue.

We earnestly hope that the day is not far distant when this society, to which Prof. Bailey gave the first impulse, will be started. The suggestion of Dr. Britton is that its journal be similar to Just's *Botanische Jahresberichte*, with this difference, that it should notice only papers printed in United States.

Is it really true that an American "Just" would be the ideal one? Would it be one most beneficial to botanical study in this country?

We cannot agree with Dr. Britton in this matter and for the following reason. Every botanist who really desires to keep himself "á jour" with our publications has so many opportunities to get the papers themselves, that a reviewing journal seems rather superfluous. The botanical papers of this country appear as a rule in some report, proceedings or in periodicals that are always easily accessible in almost every city. (The index in the Torrey *Bulletin*, however, is always welcome as a guide to what has appeared, and we hope Dr. Britton will not bring this part of the *Bulletin* to a close. The index might be printed in smaller type so as to save space, or the editors might publish it as an appendix to the *Bulletin*.)

It is true, that Just's *Jahresberichte* do not give many reviews of American literature, but this is our own fault. If the American botanists would always send copies of their papers to the editor of the *Jahresberichte*, as well as to all the leading botanical journals in Europe, in which reviews are given, they would then have the satisfaction of seeing their papers reviewed or at least referred to.

If, however, we have something like the *Jahresberichte* in this country, but confined to American literature, what would be gained? A certain class of botanists would content themselves with reading these reviews and would never look at the paper itself. We venture, therefore, to suggest a publication of an entirely different character.

The society should publish a monthly journal containing papers of a strictly scientific character, but which are too long to appear in any of the older journals. When we say "strictly scientific" we mean original researches, based upon thoroughly scientific investigations. Not "a list of plants collected here or there" or "new species of so and so" or purely systematic monographs, but solid contributions to botanical knowledge in the broadest sense, papers on geographical distribution, sketches of vegetation, studies of morphology, anatomy and physiology. These papers should appear in good form, having been first examined and approved by a board of editors, for in this way both writers and readers would be saved from seeing bad blunders and misstatements. This last feature is what we need most of all, to have our manuscripts examined and criticized before the printer puts them into immortality. We believe we would get much more satisfaction out of our work, and we certainly would have to strive a good

deal more than some of us are doing now. Still another thing would be gained. We would have uniformity in our botanical writings, in terminology for instance. This is a matter that is needed badly now, when the Century Dictionary and Crozier's Dictionary of botanical terms have done what they could to spread the worst kind of botany abroad.

The society will have much to do, but we believe there are enough to help, and when once started, it will check the existing evil C'est le premier pas qui conte.—THEO. HOLM, *Washington, D. C.*

[Mr. Holm would do well to broaden his ideas of "strictly scientific" botany.—EDS.]

NOTES AND NEWS.

BROWN UNIVERSITY bestowed upon Prof. W. W. Bailey the honorary degree of A. M. at the last commencement.

PROF. DR. L. WITTMACK of Berlin, editor of *Gartenflora* and member of the German Botanical Society, will attend the Congress in Madison.

HENRI DE VILMORIN has been appointed to represent the Société Botanique de France at the International Botanical Congress at Madison this month.

THE THIRD EDITION of *Les Maladies de la Vigne* has brought its author, Pierre Viala, well known in America, the Desmazières prize of the French Institute.

COUNT UGOLINO MARTELLI, of Florence, secretary of the Italian Botanical Society, and Prof. Luigi Macchiati of the Royal University of Modena, will be in attendance at the Madison Congress.

CATALPA SPECIOSA has just flowered for the first time in Europe, at Baden Baden, according to Mr. Max Leichtlin in *Gardener's Chronicle.* The trees were sent in 1879 by Professor C. S. Sargent.

ZOE is rapidly increasing the annotations upon our card catalogue of species, each number containing much material of all kinds. We note the name of Professor Douglas H. Campbell among the editors.

IN HIS handbook of the Pteridophytes of South Africa, just published, Mr. T. R. Sim includes 179 species, forty-two of which are peculiar to the cape. All Pteridophytes known to occur south of the tropic of Capricorn are included.

AN INTRODUCTION TO SYSTEMATIC BOTANY, by Prof. Charles E. Bessey, of the University of Nebraska is announced from the press of Henry Holt & Co. The author proposes to make the work correspond to its title. It is intended for beginners, and the students will be introduced to plants of all the groups.

THE REV. Arthur C. Waghorne, of Newfoundland, has for sale sets of Labrador Sphagna (25) for $2.00, and sets of Newfoundland and

Labrador Sphagna (44) for $4.00, named chiefly by Drs. Warnstorf and Eaton. Apply, during his absence on the Labrador, to Mr. A. T. Waghorne, City Engineer's Office S. Whies, Newfoundland.

MR. THOMAS MEEHAN has been honored by the presentation of a large and beautiful silver placque encased in carved mahogany and plate glass from the citizens of Philadelphia in recognition of his successful efforts in securing the establishment of small parks in various parts of their city. The gift is an elaborate design of high artistic merit.

A REVIEW of recent investigations upon carbohydrates written by Prof. W. E. STONE, appeared in the July number of "Agricultural Science," pages 177–186. It gives a good insight into the new and numerous investigations carried out by Tollens and his staff, as well as by others who are working under the influence of Tollens' new teachings in this particular field.—BAY.

IN A SERIES of about forty experiments carried out by W. Detmer (Ber. d. deutsch bot. Ges., XI. 139) it was found that plant organs without chlorophyll, (e. g., petals, roots, mycelium) exhaled the same amount of carbon dioxide in darkness as in light, whether direct or indirect, the temperature being kept the same. Furthermore no daily periodicity could be detected.

AN ERROR sometimes made in the formation of specific names is pointed out by Saint-Lager[1]. When the specific name takes the form of a Latin adjective, compounded from a noun and an adjective, the stem word should be united to the adjective with an *i*, although the noun may belong to the first declension. Thus, rutæfolius, tiliæfolius, calendulæflorus, tunæformis, etc., are incorrect and should be written ***rutifolius***, ***tiliifolius***, ***calenduliflorus***, ***tuniformis***, etc.

FROM RECENT REPORTS of the office of Experiment Stations we learn that there are fifty-four agricultural experiment stations in the United States, of which thirty-one employ botanists. Twenty-two stations have each one botanist, and nine have two, one of these being an assistant in most cases. This makes a total of forty persons connected with the stations who are engaged in botanical research. Of this number ten are also working in entomology, three in horticulture, one in aboriculture and one in meteorology.

A TRANSLATION of Zimmermann's work on the methods in microscopical botany by Dr. James E. Humphrey is announced for August. The work will be a very acceptable addition to manuals for the laboratory. It covers in about 300 pages the various operations of preparing various kinds of materials for the microscope, including microtome work, and the detection of organic and inorganic substances by micro-chemical methods, together with methods for bacteria. The work will be illustrated.

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[1] Un chapitre de grammaire à l'usage des botanistes. Paris, Baillière et fils, 1892.

"A NATURAL system of the action of poisons" is the title of a new book published by Dr. O. Loew in Munich. The author regards these actions with special refernece to the protoplasm, and its constituents. The book contains a rich amount of new and important facts which bear directly upon physiological and biological questions (living albumen, immunity, etc.) Complying with the author's wish, we shall give a review somewhere else; but it ought to be said here that Loew's book must receive attention from all students of physiology.—BAY.

THE BULLETINS from the experiment stations, which have come to hand since the last notice, include two (Va., no. 20 and S. D., no. 35) upon specific plant diseases and their remedies, one by T. A. Williams, (S. D., no. 33) on some plants injurious to stock (loco weeds and ergot), one by Geo. F. Atkinson (Cornell, no. 53) on œdema of the tomato, a very interesting non-parasitic disease, and one (Ohio, Tech. ser., I, 3) containing a number of articles relating to the state flora, including a full bibliography, by W. A. Kellerman, Aug. D. Selby, Wm. C. Werner, and Freda Detmers.

WEHME[1] cultivated a new fungus of which he describes two species namely *Citromyces Pfefferianus*, and *C. glaber*. It belongs to the group of moulds still imperfectly known that breaks up sugar and forms, besides other products, an organic acid. The new forms here mentioned may be caught from the air, and develop in solutions of sugar and other nutritive matter. It transforms half or more of the dextrose into citric acid, and can be used for the manufacturing of the latter. The two species named here will be more fully described later. Their maximum of growth lies below that of their fermentative power. They seem to be facultative anaërobionts. Anorganic acids, even in small proportions, and CO_2 have a deleterious effect as well upon growth as upon fermenting power.—BAY.

ZACHARIAS PRESENTS a paper in the Ber. d. deutsch. bot. Gesells. XI. 293, on the chemical constitution of the protoplasm. So far as has been ascertained certainly the cell protoplasm and the cell nucleus consist for a greater portion of their mass of substances which are insoluble in artificial gastric juice. To these substances belong the greater part of the material of the chromatin bodies of the nucleus. The other insoluble substances, heretofore passing generally under the name of plastin, show even after digestion a different reaction from those of the nucleus. Both protoplasm and the nucleus contain also proteids soluble in digestive fluid. The nucleolus is particularly rich in these, whereas the cell protoplasm, especially in full grown plant cells, seems to be poor in soluble proteid. Globulin and albumin, both of which are widely distributed in plant as in animal cells, do not seem to form a considerable part of protoplasm. The latter appears to be made up in the main of far more complex proteid substances.

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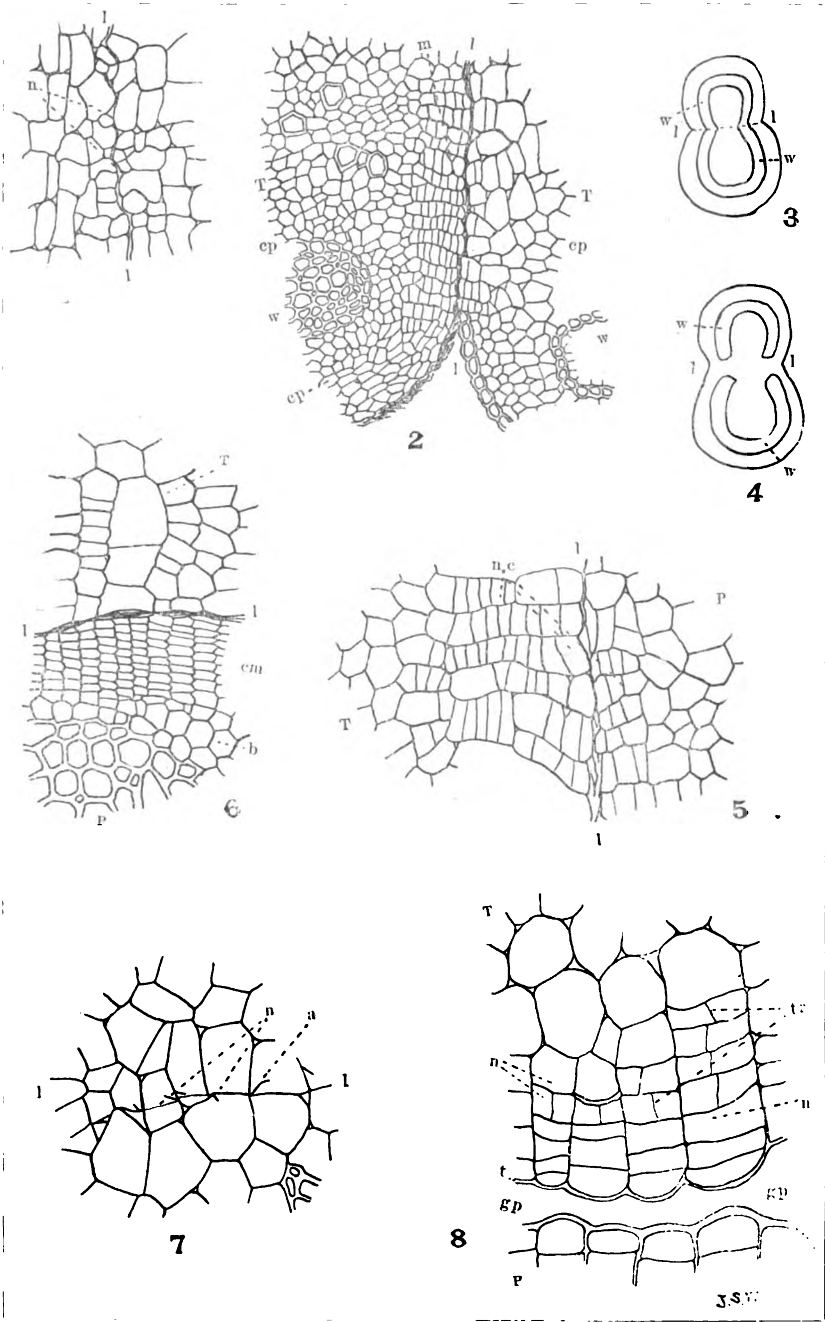
[1] Ueber Citronensäure-Gährung. (Sep. from. Sitzungsber. d. kgl. preuss. Akad. d. Wiss. zu Berlin. XXIX. pp. 519–523, 1893.)

Belajeff's earlier researches on the germination of the pollen grain in the conifers and the homologies of its organs have been referred to in this place. More recent researches support his earlier ones and his conclusions on the homologies are interesting. He finds that the pollen tubes of the Abietineæ have the most complex structure, because at the base of the tube there are two small fixed cells which he considers the vegetative cells of the prothallium. The large cell which forms the tube is homologous with the antheridium of the cryptogams. This antheridium consists of a large outer cell, which extends to form the tube and answers to the wall-cells, and of an inner cell which is the equivalent of the mother cell of the spermatogenous complex. This mother cell divides into three cells, of which the two anterior function in fertilization while the third is disorganized. In the Cupressineæ, however, the structure of the pollen tube is much simpler, since there are no fixed cells, the entire prothallium being reduced to an antheridium which is like that of the Abietineæ. In Taxus a further simplification occurs in that the mother cell in the antheridium divides into only two cells of which one is functionless. The parts in the angiosperms are essentially as in Taxus.—Cf. *Ber. d. deutsch. bot. Gesells.* XI (1893). 198.

The occurrence and physiological significance of myrosin in plants has been the subject of a research by Wilhelm Spatzier. His results are published in Pringsheim's *Jahrbücher*, xxv. (1893). 39, and may be thus summarized. Myrosin occurs in the Cruciferæ, Rosedaceæ, Violaceæ, and Tropaeolaceæ; in the first two in the seeds and vegetative organs, in the last two only in the seeds. In the seeds and vegetative organs of the Cruciferæ and in the seeds of the Tropaeolaceæ it is found in special cells, the myrosin tubes. In the aerial vegetative parts of the Resedaceæ it is contained exclusively in the guard cells of the stomata; the roots contain no myrosin. In the seeds of Viola and Reseda no myrosin tubes could be discovered. In the myrosin tubes of the vegetative organs the myrosin exists in a dissolved state, whereas in seeds which are poorer in water, it is always in solid homogeneous granules, without inclusions, about the size of the aleurone grains. It is a product of the protoplasm. Its formation is independent of light and continues as long as the formation of new organic material goes on. From the parts of a plant which are becoming functionless it is sometimes not, sometimes partially, but never wholly, resorbed; so that it seems to be intermediate between secretions in the strict sense and reserve material. Myrosin doubtless serves to form glucosides, of which however we know but two, potassic myronate and sinalbin, the latter being the so-called "mustard oil." What other glucosides it may form and what their rôle in the plant economy may be is unknown.



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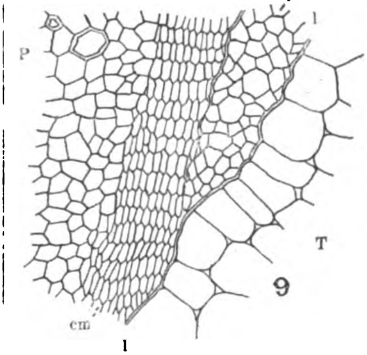

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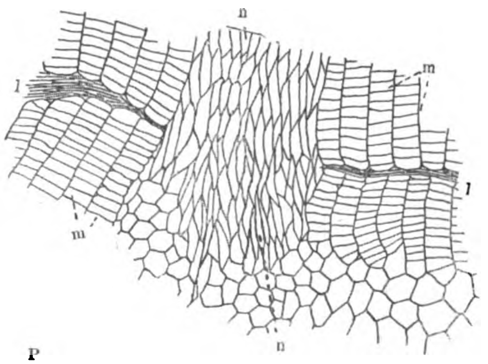

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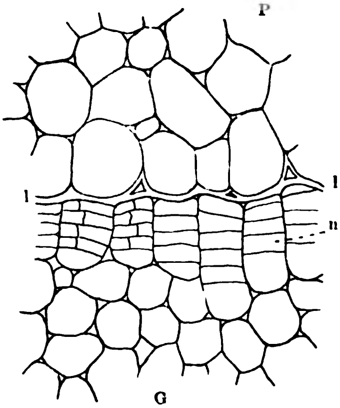

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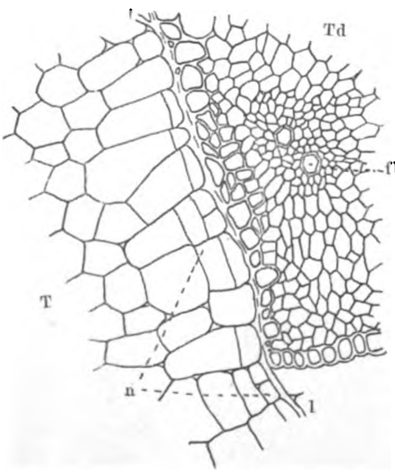

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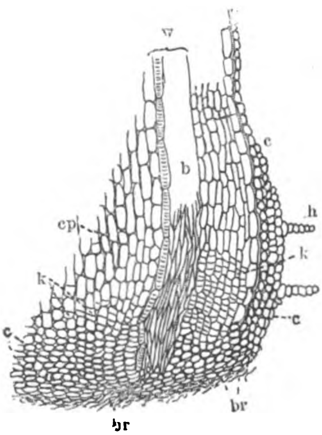

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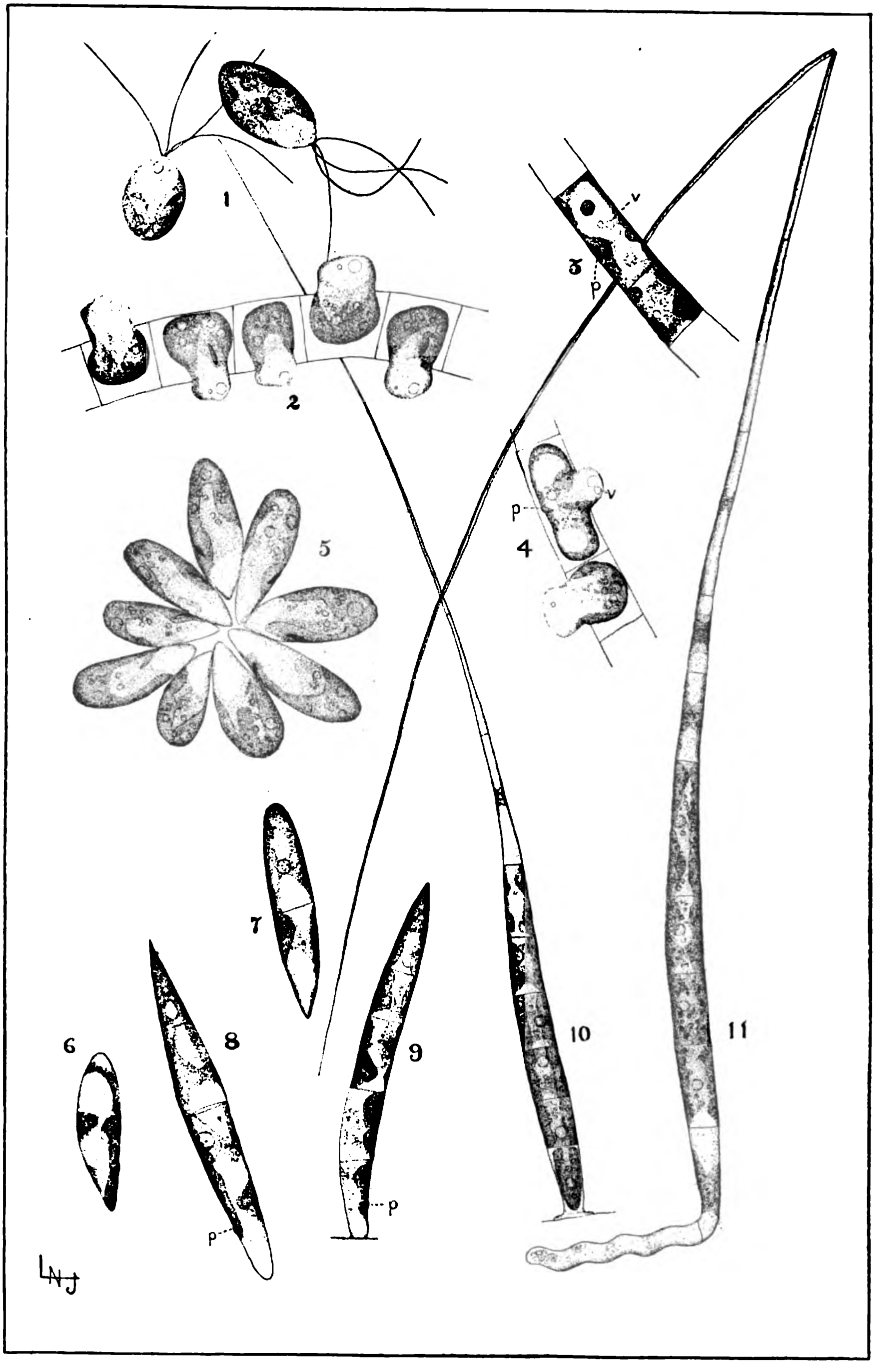

JOHNSON on DRAPARNALDIA.

BOTANICAL GAZETTE

SEPTEMBER, 1893.

Evolution and classification.[1]

CHARLES E. BESSEY.

As we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple of botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialization so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all, the grouping in orderly sequence of the organisms themselves, whose histology, morphology and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master mind of Darwin. In

[1]Abstract of Vice-presidential address before Section G of the American Association for the Advancement of Science, Madison meeting, August, 1893.

its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore in the light of evolution we now see the meaning of many reduced structures whose significance was not at all or but vaguely understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the fungi, where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are many cases of a catagenesis not due to a dependent habit, in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of a willow is simple by a degeneration from a higher type, probably a tricarpellary or pentacarpellary type, by the loss of its floral envelopes and stamens and pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis, for we know it as a great biological fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a sys-

tem there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants, at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution, they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honored work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhered to the artificial system of Linné. Now sixty years later we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that with the change of a word here and there the arguments *pro* and *con* then used may be used to-day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants, as was that of Linné sixty years ago, and now, as then, it is the spirit of conservatism and of veneration for time honored usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which, as nearly as may be, represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification

must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome is primitive and lower, the compound pistil is derived and higher. The several-seeded, compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive; united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So too when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts, and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is. unscientific because it absolutely fails to conform to the laws of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old, when the old is no longer the true; it tears down the work of years, when that work no longer represents the truth; and it dares to reach out and frame a rational system even though some parts of it for a time rest upon hypothetical grounds.

A revised arrangement of the Benthamian "series" of flowering plants.

Monocotyledons.

1. Apocarpæ.	5. Glumaceæ.
2. Coronarieæ.	6. Hydrales. (Hydrocharideæ).
3. Nudifloræ.	7. Epigynæ.
4. Calycinæ.	8. Microspermæ.

Dicotyledons.

"POLYPETALÆ."

1. Thalamifloræ. (Including the apetalous Curvembryeæ, Micrembryeæ, and "Ordines anomali" and the Euphorbiaceæ and Urticaceæ, etc., of the Unisexuales.)
2. Discifloræ. (Including the apetalous Daphnales and the Juglandaceæ and Cupuliferæ, etc., of the Unisexuales.)
3. Calycifloræ. (Including the apetalous Aristolochiaceæ and Cytinaceæ).

GAMOPETALÆ.

1. Heteromeræ. 2. Bicarpellatæ. 3. Inferæ.

University of Nebraska, Lincoln.

Proceedings of Section G, A. A. A. S., Madison meeting.

The American Association for the Advancement of Science convened in Madison, Wis., Thursday, August 17, 1893, and continued in session until the succeeding Tuesday. The following account is an outline of the addresses, papers and discussions before the section of botany, in the order in which they were presented.

THURSDAY AFTERNOON, AUGUST 17.

The address of Vice-President C. E. Bessey upon *Evolution and Classification* was given before the Section of Botany at half-past four o'clock, occupying one hour. An abstract of the address is printed in the preceding pages of this number.

FRIDAY MORNING, AUGUST 18.

The Section was called to order at 10:30 o'clock, Vice-President Bessey in the chair, and B. T. Galloway as secretary pro tem., with about forty persons present. The reading of papers began at once.

1. GEO. F. ATKINSON: *Photography as an instrument for recording the microscopic characters of micro-organisms in artificial cultures.*—In the usual method of lighting for photographing plate cultures, the finer characteristics are usually lost, and in case of very transparent colorless organisms the image is throughout very dim. By covering the bottom and

top of the culture dish with an opaque screen the light is admitted only through the sides of the dish, and the object is thus photographed by reflected, instead of transmitted light. In this way very clear and minute details are obtained. Many fine photographs illustrating the method and its superiority to the usual method were shown.

The paper was discussed by Messrs. Galloway and Lasché. The author stated that he used Petri dishes, and that he considered the method most serviceable in differentiation.

2. G. F. ATKINSON: *Symbiosis in the roots of Ophioglosseæ.*—In examining the roots of Botrychium Virginianum attention was called to masses of yellowish protoplasm located at definite points in the cortical parenchyma. From them threads extended to the outside, branching profusely in connection with the masses. Examination of large sets of Botrychium and Ophioglossum from all over the world revealed these structures in all. As root-hairs are not found in the Ophioglosseæ, it was suggested that this fungus was of great service in the work of absorption, and that probably this habit prevails in all Ophioglosseæ.

Discussed by Messrs. Smith (Erwin F.) and Swingle.

3. B. T. GALLOWAY: *Observations on a rust affecting the leaves of the Jersey or scrub pine.*—A full description of the rust (*Coleosporium Pini*) was given, and the course of its development, especially the conditions and time of its transformations were fully described. Infection only takes place when the leaves are tender, from one-fourth to one inch long, and is usually confined to a period not exceeding two weeks.

In the discussion Professor Kellerman said that the Jersey pine (Pinus Virginiana) was abundant in southern Ohio, from near Columbus southward, and was associated with the pitch pine (P. rigida). He had not found the fungus on the former species in that state, but it was common upon the pitch pine throughout the region. Professor MacMillan mentioned an unusual case of hypertrophy due to such a parasite, observed in Minnesota, in which trees twenty to thirty years old only attained the height of a man, the whole tree becoming a kind of witch's broom.

4. W. J. BEAL: *Prophylla of Gramineæ.*—These structures were described, using corn and oats as examples. With a view to discovering their value as a diagnostic character, 150 species belonging to fifty-six genera were examined. The

conclusion was reached that while the lengths of prophylla hold some relation to the lengths of sheaths, the character of the apex is of chief service in classification, varying as it does from acuminate to bilobate. Such distinctions are sometimes specific, sometimes generic.

Discussed by Mr. Swingle, who suggested that prophylla show an adaptive character in the protection of young branch buds.

5. CHARLES R. BARNES: *On the food of green plants.*—A discussion of various nutritive processes, suggesting the proper application and restriction of the terms "digestion" and "assimilation," claiming that the true food of plants was not the "food" of ordinary reference, and proposing the application of the term "photosyntax" to the construction of carbon compounds under the influence of sunlight. [The paper will appear in full in the BOTANICAL GAZETTE.]

Discussed by Messrs. Britton, Smith (E. F.), Swingle and MacMillan.

FRIDAY AFTERNOON, AUGUST 18.

6. J. CHRISTIAN BAY: *A new infection needle for the study of lower plants.*—A pointed wire, about six inches long, bent around at one end to form a handle, and sharpened at the other, is thrust through a metal disc, an inch in diameter. The disc acts as a screen to prevent contamination from falling dust and germs when transferring infection to or from liquid cultures of micro-organisms.

7. G. F. ATKINSON: *Comparative study of the structure and function of the sporangia of ferns in the dispersion of spores.*—The nature of the annulus in various ferns was described, the spring cells, lip cells, and connective cells in each case being discussed, and attention called to the function of each one of these regions in reference to scattering spores. The question was also raised as to the proper application of the terms "complete" and "incomplete" in reference to the annulus.

8. BYRON D. HALSTED: *The Solandi printing applied to botanical work.*—The object to be reproduced is placed upon plain glass in an ordinary photographic printing frame, backed with Aristo, or other sensitive paper, and exposed to light in the usual way of making a photographic print. When the print is fixed with "hypo," it is made transparent with kerosene, and thus becomes a negative from which any number of positives may be printed. The process is suitable to fresh

leaves, sections of wood, and all kinds of thin semitransparent objects, including drawings and book illustrations. Dried leaves may be made sufficiently transparent by immersion in kerosene. If the object is moist, like fresh sections of fleshy tubers and roots, a sheet of mica can be laid between the object and the sensitive paper. Many beautiful examples of the diversified application of the process were shown. (The name is a fanciful compound of Sol-and-I.)

Discussed by Mrs. E. G. Britton, W. A. Kellerman and A. B. Seymour, who described photographic methods which they had used. The last had found two sheets of glass clamped together, when copying from bound books, quite as efficient as the printing frame, thus overcoming the necessity of cutting out the leaf.

9. N. L. BRITTON: *Present aspects of the nomenclature question.*—The paper was presented by request and consisted simply of a statement of the different views held in recent times, with no attempt to discuss their relative merits. With reference to genera, the various positions as to the date of their recognition were grouped as follows: (1) Pre-Linnæan (naturally subdividing into those who would recognize genera from the earliest possible date, and those who would carry them back as far as Tournefort), (2) 1735, (3) 1737, (4) 1753, (5) those who would use a more recent limitation. As to species, the two views are represented by those who would recognize binomials before the time of Linnæus, and those who would date them entirely from 1753.

Discussed by Mr. E. L. Greene, who did not contend for pre-Linnæan binomials, but for the practice of crediting such names as Linnæus adopted from former authors to the respective authors. Mr. Seymour called attention to the fact that this method was in use in quoting the names used by Fries, although in this case the authorities cited were all subsequent to Linnæus.

10. T. A. WILLIAMS: *Lichens of the Black Hills.*—A list was submitted containing eighty-three species and varieties, and the paper read considered only the subject of distribution. Of the eighty-three species forty-five are rock forms, eight are tree forms, twenty-one are earth forms, the remainder occupying combined localities. Comparisons were made with the lichens of eastern Nebraska and those of Idaho and the Yellowstone Park region as published in the report of the

Hayden Survey for 1872. The conclusion was reached that the Black Hills lichens are of northern mainly subalpine character, and while more closely allied to the Rocky Mountain flora, are intermediate between that and the flora of eastern Nebraska. The varying preponderance of tree, rock, and earth forms was attributed to certain geological and climatic conditions.

11. J. CHRISTIAN BAY: *The bibliography of American botanical literature.*—Attention was called to the advantages which would come from the publication of an index of American writings. Mr. Bay instanced the great value of the index of chemical literature conducted under the auspices of the Association. He offered the suggestion that Section G (Botany) appoint a committee to undertake the work.

Several members discussed the subject, but all thought that there was need of taking more time to fully consider the matter.

12. DOUGLAS H. CAMPBELL: *Notes on the development of Marattia Douglasii.*—The material for study was obtained during the author's recent visit to Hawaii. It was claimed that the study further strengthened the view that the eusporangiates are the primitive forms. Although the complete history of the prothallia was not made out, that of the sex organs was obtained. The antheridia in structure most nearly approach those of Equisetum. The archegonia are on the under side, and in its development the embryo retains its direct upward growth and bursts through the prothallium which remains surrounding the base of the plantlet probably for almost a year, continuing to do vegetative work after the sporophyte is independent. The development of the archegonium neck was discussed, and the transition between the archegonium of bryophytes and that of pteridophytes suggested. The whole structure was taken to indicate the primitive nature of Marattia, and the author regarded it as the nearest form to the liverworts yet examined, especially approaching the Anthoceroteæ.

Discussed by Mrs. Britton and Messrs. MacMillan and Atkinson.

13. M. B. THOMAS: *The roots of orchids.*—In the absence of the author the paper was read by title.

14. L. H. PAMMEL: *Preliminary notes on some chromogenic bacteria of the Ames flora.*—In the absence of the author the paper was read by title.

15. B. T. GALLOWAY: *Results of some recent work on rust of wheat.*—In the absence of the author the paper was read by title.

MONDAY MORNING, AUGUST 21.

16. THEOBALD SMITH: *Further observations on the fermentation tube with special reference to anaerobiosis, reduction and gas production.*—The different forms of the group of Bacillus coli produce gas when glucose is present in the culture medium, and in about equal amounts and equal rapidity. They have a varying behavior toward other sugars, however. The introduction of potash shows that about one-third of the gas produced is carbon dioxide, and the remainder of the gas is explosive, being probably hydrogen. Methylene blue put into the fermentation tube will be decolorized by the growth of the germs, but when mixed with air the fluid becomes colored again. The classification of bacteria into those causing alkaline and those causing acid reaction of the medium is not tenable, as these changes depend upon the nutritive constituents of the medium.

Mr. Lasché stated that he had found what he took to be a loss of albuminoids during such fermentation, and that no sugar was withdrawn; but that he was not yet prepared to defend this view.

17. JOHN G. JACK: *The fructification of Juniperus.*—Much uncertainty of statement existing concerning the length of time involved in fructification, the author studied J. Virginiana, J. Sabina, var. procumbens, and J. communis. He found that the fruit matured in one, two, and three years, in the order given. The morphology of the so-called "ovule" was also discussed. [The paper will be published in full in the GAZETTE.]

18. S. G. WRIGHT: *The minute structure and development of the motile organ in the leaf of the red-bud.*—An historical sketch of the subject was given and the anatomical structure of the pulvinus. The leaf begins to rise at three A. M., reaches a maximum at nine A. M., then falls, reaches a second maxium at two P. M., and then falls until at ten A. M. it reaches its full "sleeping" position. The arrangement of tissues in petiole and pulvinus was described. The pulvinus was said to be a development of parenchyma cells about the petiole, corresponding in time and method of cell-division to the mesophyll cells. All the tissues of the pulvinus are so arranged as to secure movement with the least possible expenditure of energy.

MONDAY AFTERNOON, AUGUST 21.

19. ERWIN F. SMITH: *Two new and destructive diseases of cucurbits.*—The first disease was observed in melons in Michigan, and is produced by a parasitic Alternaria, which was separated and cultivated upon agar-agar. Artificial infection was obtained by sowing the spores from the pure cultures. It produces large brown spots on the foliage, and has been called "rust." Although very destructive to melons, it does not appear to affect cucumbers. The second disease attacks cantaloupes and cucumbers, and is specially characterized by a sudden wilting of the foliage. Much of this wilting is due to cutting off the water supply from the parts beyond by the disease extending into the stem. It is produced by bacteria, which have been separated, and artificial infection produced. Cut stems from diseased portions, when put into moist air, exlude viscid drops filled with bacteria. The spread of the blight is associated with the puncture or eating of the plant by insects, and is most abundant in dry weather when leaf-eating insects are common. Bordeaux mixture proved wholly ineffective as a preventive.

The paper was discussed by Messrs. Arthur and Jones.

20. CONWAY MACMILLAN: *Preliminary statement concerning botanical laboratories and instruction in American universities and colleges.*—Circulars were sent to all American universities and colleges, but the result was not entirely satisfactory. In some cases no information could be obtained, in others the information was vague. The author rapidly sketched the offered courses and equipment in the various colleges from which information had been obtained, showing a remarkable inequality in the presentation of botany. It was stated that the united herbaria of the country represented about three million specimens, and the united botanical libraries from 230,000 to 250,000 volumes. Broadly speaking, the colleges could be divided into three groups on the basis of botanical instruction: (1) those which do such work as that offered by Gray's "Lessons" and the "analysis" of a few flowers; (2) those which simply study types, after the Huxley and Martin method, and have little or no botanical tendency; (3) those with well-developed courses in all the various phases of botanical activity.

In consequence of the discussion which followed, participated in by Messrs. Bessey, Barnes, Underwood, Keller-

man, Britton and others, a resolution was passed requesting the Commissioner of Education to publish a monograph on the subject, to be prepared by Professor MacMillan.

A motion was also passed for the appointment of a committee to report at the next annual meeting of the section concerning some feasible way by which the section might use its influence in securing better botanical instruction in secondary schools. J. M. Coulter, D. H. Campbell, and N. L. Britton were appointed.

21. BYRON D. HALSTED: *The shrinkage of leaves in drying.*—Contact photographs of fresh leaves, with the leaf from which they were taken dried and mounted at one side, were exhibited. These showed the exact amount of shrinkage in each instance, which was often surprisingly large.

Mr. Kellerman thought the specimens were more shrunken than usual in herbarium specimens. Mr. Swingle thought the matter an important one in connection with transpiration experiments, in which the measurement of the area of the leaf is often deferred until it is dry. Mr. Jack spoke of using cotton to fill under rigid stems in the press, in order to make the leaves dry smooth and flat.

22. J. H. PILLSBURY: *On the quantitative analysis of the colors of flowers and foliage.*—In the absence of the author the paper was read by title.

TUESDAY MORNING, AUGUST 22.

23. S. M. TRACY: *Distribution of the Gramineæ in the United States.*—There are 112 genera in our territory. The distribution of the more important species, both indigenous and introduced, was traced and maps were shown.

24. N. L. BRITTON: *A consideration of species based upon the theory of evolution.*—The earth's flora was comparatively uniform to the end of the carboniferous period, and nearly as much so up to the close of the cretaceous. The segregation into various floras has thus taken place in comparatively recent times. This should make one hesitate in calling closely related forms one a variety of the other, rather than two incipient species.

Mr. Coville thought that for the proper advancement of systematic botany closely related forms should receive ample consideration. Whether it is possible to consider forms which do not intergrade as good species, and those which do as varieties, must yet be determined by working botanists.

25. ELIZABETH G. BRITTON: *A revision of the genus Physcomitrium.*—Physcomitrium pyriforme of the Manual is not P. pyriforme of Europe, but is P. turbinatum, which proves to be our most widely diffused species. An interesting new species is also described from California under the name P. sphærotheca. Instead of six species in the United States, there are probably nearly double that number. Florida forms of this genus are probably referable to three distinct species.

Mr. Barnes thought the separation of P. turbinatum from P. pyriforme well taken.

26. W. T. SWINGLE: *Cephalurus mycoidea and Phyllosiphon sp., two parasitic algæ new to North America.*—The latter of these algæ was gathered in the Dells of the Wisconsin river, three days before (Aug. 19th), and heretofore known only from a few places in Europe. It forms pale spots upon the leaves of Arisæma, and is probably widely distributed. The alga is a genuine parasite, living within the tissues of the leaf. The suggestion is made that this habit may explain one way in which fungi have been derived from algæ without having passed through aquatic forms. The first alga mentioned is a parasite upon Magnolia, and has been found in this country before by lichenologists, but not reported.

TUESDAY AFTERNOON, AUGUST 22.

27. FREDERICK V. COVILLE: *An analysis of the conditions affecting the distribution of plants.*—The environmental conditions of plants, when reduced to their lowest terms, are heat, light, water, food, air and mechanique.

Mr. MacMillan thought it would be well to include evolutional factors, including the energy of the plants, which are not provided for in the classification. Mr. Swingle called attention to the important part played by fire in determining distribution. Mr. Coville explained that this was not classified as an ultimate condition, but was put under heat. He also said that tension, as used by MacMillan, was included under mechanique.

28. J. C. ARTHUR: *Deviation in development due to the use of unripe seeds.*—It was shown that immature seeds bring about weakness in the seedlings, causing a greater number than usual to die before becoming established, a lack of vigor that is never fully recovered, and an increased development of the reproductive over the vegetative parts, causing a comparatively greater fruitage. It was pointed out that such

changes could also be brought about by any agency that lowered the vitality of the plant.

Discussed by Messrs. Bolley and MacMillan. [The paper will be published in full in the *American Naturalist.*]

29. W. T. SWINGLE: *The principal diseases of citrous fruits now being studied at Eustis, Fla.*—A trouble characterized by wilting shows well at a distance, but the microscope gives no additional information. It is thought to be due to some physiological check to transpiration. Mal di goma is a common disease connected in some way with a lack of proper respiration at the roots of the tree. "Die back" is a disease marked by a great variety of symptoms. The name is due to the usual dying back of the ends of the branches. Fruit and leaves are also affected. It is known to be increased by excess of nitrogen in the soil. A local disease of less importance than the preceding causes corky excrescences upon the fruit.

30. P. H. ROLFS: *A sclerotium disease of plants.*—Especially affects tomato, potato, egg-plant and melons, but has been found in seventeen species belonging to widely different orders. Sclerotia are abundantly formed in the stems near the ground, which give rise to mycelium on culture media, but not to spores. The relationship of the fungus has not been determined.

31. ELIZABETH G. BRITTON: *Ulota Americana* Mitten *and Orthotrichum Americanum* Beauv.—Dealt altogether with the tangle of synonymy in which these names are involved.

32. L. H. PAMMEL: *Notes on Roestelia pyrata.*

33. L. H. PAMMEL: *Crossing of cucurbits.*

34. L. H. PAMMEL: *A case of poisoning by the wild parsnip, Cicuta maculata.*

In the absence of the author these papers were read by title.

Proceedings of the Botanical Club, A. A. A. S., Madison meeting.

FIRST SESSION, FRIDAY, AUGUST 18, 9 A. M.

The Club was called to order by Vice-president W. A. Kellerman, the president, W. P. Wilson, and Secretary, T. H. McBride, both being absent. Mr. W. T. Swingle was

made Secretary *pro tem.* and served throughout the sessions. About thirty persons were present, and the attendance ranged from thirty to fifty for the subsequent sessions.

The report of the standing committee on nomenclature, to which had been referred the preparation of a check-list, was called for, and presented by its chairman, Mr. N. L. Britton. The manuscript, almost ready for the printer, was presented, but before printing was ordered, the committee made certain recommendations, which were considered *seriatim:*

1. That the rules of nomenclature adopted at Rochester be so amended as to permit the retention of a specific name even when it involves a duplicate binomial, and also when it conflicts with a later specific name described in the genus to which it has been transferred. The two parts of the recommendation were taken up separately; that which referred to duplicate binomials receiving the larger share of attention. This unanimous recommendation of the committee was made as a result of their work upon the check-list, although one year ago they were as unanimously opposed to it. The recommendation was fully discussed by Messrs. Bessey, Coville, Greene, MacMillan, Britton, Coulter, Kellerman, Swingle, Seymour, Davis, Atkinson, and others, the impression prevailing that the principle of the permanency of the specific name is more important than that of homonyms. The recommendation in favor of duplicate binomials was adopted by a very large majority. The recommendation favoring the retention of the older specific name when transferred to a genus in which the same specific name had been subsequently used, after brief discussion and explanation, was also adopted.

2. That the sequence of orders in the check-list be that of Engler and Prantl's *Die natuerlichen Planzenfamilien.* This was unanimously adopted, not that the sequence referred to is in all respects the best, but because it is at present the most convenient presentation of a natural arrangement.

3. That precedence in the same volume be regarded as priority. Unanimously adopted.

4. That the varietal name be subject to the same laws of permanency as those which govern the specific. In the discussion which followed Messrs. Britton, Greene, Coville, Smith, (E. F.), Underwood, Coulter, Atkinson, Seymour, and Mrs. E. G. Britton, took part, and the Club adjourned without reaching a vote.

SECOND SESSION, MONDAY, AUGUST 21, 9 A. M.

The second session opened with thirty-five persons present. The treasurer's report was read, showing a deficit of about six dollars, which was subsequently more than covered by voluntary contributions from the members. A committee formed of A. S. Hitchcock and E. F. Smith to nominate officers for the ensuing year was then appointed, to report on Tuesday.

Papers or brief addresses were presented as follows:

MRS. E. G. BRITTON: *The genus Bruchia.*—The mosses of this genus are minute, and mostly American; only two types had to be sought in Europe. The work brought out several new species, and the doubtful ones were noted.

MRS. E. G. BRITTON: *The necessity of seeing types.*—A number of instances of the imperfection of descriptions, and of otherwise unobtainable information secured from the original specimens, were given, emphasizing the fact that even in the case of the most conscientious and careful botanists the examination of their type specimens is sometimes required for identification.

Mr. Greene thought that the necessity for seeing types grew largely out of the imperfect use of the English language and a lack of appreciation of what constitutes true characters, in the Linnæan sense. Mr. Underwood spoke of the difficulty sometimes experienced in ascertaining where types are to be found, and mentioned the Mexican collections stored in Paris. Miss Harrison spoke of the types in the National Herbarium at Washington, and further remarks were made by Mr. Kellerman.

A. S. HITCHCOCK: *The forms of Ampelopsis.*—Fresh specimens of *Ampelopsis quinquefolia* were exhibited and attention called to the form which does not climb. The leaflets are stalked and taper to the base, the cymes are dichotomous (not racemose), the canes smooth and of different color, discs only rarely present (flowers not studied). Its characters are of the *Cissus* type, and he is inclined to think it a good species.

Mr. Swingle stated that he had found the form with discs well developed.

J. C. ARTHUR: *A centrifugal apparatus.*—The speaker exhibited a new pattern of centrifugal for demonstrating the sensitiveness of roots and stems of seedlings to centrifugal

force, an indirect way of explaining geotropism. A disc of cork, about five inches in diameter, to which the seedlings are pinned, and kept moist by constant dripping of water, is revolved from 400 to 1,200 revolutions per minute. The disc is enclosed to prevent evaporation, and is adjustable at any angle. The disc is run by a small electric motor and batteries.

D. T. MACDOUGAL: *The sensitiveness of tendrils.*—Read by Mr. Arthur. Many observations were brought forward to show that the supposed power of tendrils to discriminate between contact with their own organs and foreign bodies does not exist, and that even those of the most sensitive species often coil about other tendrils upon the same plant.

MRS. E. G. BRITTON: *The Jaeger collection.*—The speaker narrated the efforts which had finally been crowned with success, by which a very large collection of mosses, containing many valuable exsiccati had been obtained from Geneva, for the Columbia College herbarium.

W. A. KELLERMAN: *The distribution of some woody plants in Ohio.*—Among other items he noted that the umbrella tree is not a native of the state, although it has been so reported.

A. S. HITCHCOCK: *Observations on the pollination of Œnothera Missouriensis.*—The large flowers open just before dark, although the stigmas protrude as early as two o'clock in the afternoon. Only a single species of insect, a large sphinx moth, has been seen about the flowers. This comes about eight o'clock, and is active until darkness sets in.

ERWIN F. SMITH: *The serious prevalence of root diseases.*—Tumors upon the roots, of which the cause is not known, occur in various parts of the country, but especially in California, and prove very destructive to nursery stock of apricot, plum and peach, as well as to other and older trees.

The common occurrence and injurious nature of the disease in California was confirmed by Mr. Campbell.

D. H. CAMPBELL: *The prothallium of Botrychium.*—Specimens were shown by the speaker who spoke of its rarity in collections. It is of considerable size, remains attached until the plant is quite large, and yet might readily be overlooked, being mistaken for a part of the root system.

C. E. BESSEY: *The use of personal names for species.*—Linnæus made little use of them, there being less than one per cent. to be found in his Species Plantarum. In marked

constrast to this are the reports of the National Herbarium for 1891, containing twenty-three per cent., and for 1892, containing eighteen per cent. of personal specific names. It is well to honor great men by the dedication of genera, but in doubtful taste to make more than a sparing use of personal names for species.

Mr. Britton said that the name of the collector was often more indicative than that of the country, as the travels of the collector are at first more definitely known than the range of the species. In large genera it is often difficult to obtain other names that are truly descriptive. Mr. Seymour made reference to a collector who insisted that his new species should bear his name. Mr. Coulter thought that personal ambition had very little influence, and that the practice could be upheld to some extent by the advantage in giving a name that is not likely to be duplicated, even if transferred to another genus. Mr. Bessey said he only wished to protest against the abuse of the practice, and did not advocate its abolition.

The Club adjourned until Tuesday morning.

THIRD SESSION, TUESDAY, AUGUST 22, 9:15 A. M.

The report of the nominating committee was received, and confirmed, thus electing the following officers for the year 1894: Dr. Douglas H. Campbell of Palo Alto, Cal., President; Dr. N. L. Britton of New York City, Vice-President; and Mr. W. T. Swingle of Eustis, Fla., Secretary.

The report of the committee to prepare a check list was again taken up. Mr. Greene reminded the Club that this committee had sent out a circular letter in regard to capitalization and punctuation, which was not mentioned in the report. Mr. Britton replied for the committee that about sixty of the circulars of inquiry were sent out, and that about forty or forty-five answers were received. The committee itself stood four in favor of the older American usage of capitals, two in favor of modifying it so as to remove the capital from geographical specific names, and one in favor of complete decapitalization. The returns from the circulars gave fourteen in favor of the first method, five for the second and twelve for the last. In reference to the use of the comma between the specific name and the authority, four of the committee wished to abandon it and three to retain it, while the returns from the circular gave eighteen for discarding and thirteen for re-

taining it. In view of the rather even division of opinion the committee did not feel authorized to decide.

Mr. Greene offered a motion that the committee conform to the accepted usage in regard to capitals. To illustrate the necessity of this he cited the following illustration: Three of the species of Lythrum are L. alatum, L. Hyssopifolia and L. Thymifolia. The genus name is neuter, as shown by the neuter adjective "alatum." "Hyssopifolia" and "Thymifolia" are old substantives, but if the capital is reduced to lower case initial, they become feminine adjectives, which of course is inadmissible. After some discussion the motion was laid upon the table until such time as other members of the Club, who were interested in the subject, could be present.

The report of the committee appointed last year to consider the advisability of the establishment of an American botanical society was presented by Mr. Barnes. A letter from Mr. L. H. Bailey, chairman of the committee was read, as virtually the report of the majority in favor of abandoning the attempt for the present. Eight of the committee thought its organization by the Club impracticable, one favored the organization but offered no plan of procedure. Mr. Barnes, the remaining member, submitted the following report:

As a member of the committee appointed last year to report on the feasibility of forming an American botanical society I find myself unable to agree with the majority in reporting that such organization through the initiative of the Botanical Club is not feasible at present. Another member of the committee also dissents from the majority report, viz. Prof. F. Lamson-Scribner; but I am not able to say whether he would approve of the plan which I suggest, as I have had no opportunity of submitting the same to him.

At the time the plan was broached for the formation of a national botanical society I was not in favor of it, believing that the time was not yet ripe for such an organization. On thinking over the matter during the year past I have become convinced not only that the time is opportune, but that the Botanical Club, an open association of the loosest possible organization, can establish a restricted society without friction, and with great benefit to the science of botany.

I therefore submit the following suggestions in lieu of the majority report. I recommend:—

1. That the Botanical Club approves the formation of an American botanical society whose membership shall be restricted to those who have published worthy work and are actively engaged in botanical investigation.

2. That to this end the Botanical Club proceed to elect ten men who beyond all question should belong to a society so restricted.

3. That these ten be directed to select fifteen additional members who in their judgment fall well within the limits suggested.

4. That the twenty-five persons so chosen be invited to become the charter members of the botanical society, to proceed to organize the same, and to provide for the election of additional members by such methods and on such terms (not incompatible with the intent of recommendation 1) as they see fit.

On written ballot the report of Mr. Barnes was adopted by a two-thirds majority of the Club as a minority report, after a lengthy discussion by Messrs. Campbell, Britton, Halsted, Smith (E. F.), Seymour, Jack, Bolley, Coville, and others. Balloting (without nomination) for ten members of the new society was then begun, but not completed until the afternoon session.

J. C. ARTHUR: *A new auxanometer.*—The speaker exhibited a new form of self-recording auxanometer in which the registration is made upon blackened glass rods as they pass, at regular intervals, a bristle attached to the growing plant. He claimed that it was more readily adjusted, less easily deranged, and less expensive than the usual kinds. Permanent records are quickly secured by making blue prints from the rods.

W. T. SWINGLE: *The sub-tropical laboratory at Eustis, Fla.*—The building was described, with the aid of a ground plan. It was built, and an acre and a half of ground purchased, by the citizens of Eustis and fruit growers of the region, and presented to the U. S. Department of Agriculture. It is devoted to the study of the diseases of citrous fruits. There are six rooms, well lighted and provided with water, gas, compressed air, reagents and other facilities for research. One room is for a visitor's laboratory, where the visiting biologist will receive all facilities for work that the region can afford, except the use of a microscope, which he should bring with him.

W. T. SWINGLE: *A new Florida palm.*—The plant resembles the sabal palm, but has smaller leaves and different fruit. Like the sabal palm it has an underground development of stem, which serves to preserve it from total destruction by fire.

B. D. HALSTED: *A new form of Exobasidium.*—The species occurs upon Azalia and Andromeda. It is almost confined to the inflorescence causing it to enlarge, grow erect, and produce flowers with separate petals in place of the usual gamopetalous corolla. He also spoke of a Phyllosticta (*P. cruenta*), which follows a leaf miner upon *Polygonatum biflorum*, photographs of which were shown.

Adjourned to meet in the afternoon.

FOURTH SESSION, TUESDAY, AUGUST 22, 3:30 P. M.

At the closing session of the Club a final ballot for the first ten members of the new botanical society was taken, and the names announced. (See page 368.)

The deferred report of the committee on a check-list was taken up, and the motion which had been pending, recommending the usual capitalization of specific names was withdrawn. Mr. Barnes thought the matter of punctuation might well be settled. Mr. Bessey felt that neither in this or in capitalization should the printed list of the committee be considered final, but only tentative. Mr. Trelease and Mr. Greene thought it would be best to settle these points now. A motion to refer all unsettled matters to the committee with power to act was carried. Upon motion of Mr. Britton the committee was increased from seven to nine, and E. L. Greene and Wm. Trelease named by the chair as the additional members.

A. B. SEYMOUR: *Synonymy in the genus Valsa.*—Instances of badly mixed synonymy in this genus were given as an illustration of the tangle which sometimes has to be straightened out by the cataloguer. He also called attention to a key to the species of Cladonia prepared by F. L. Sargent, of which he showed blue prints prepared by himself.

B. D. HALSTED: *A case of infection of black knot of plum.*—The infection took place in 1892, the results appearing in June, 1893. There was good circumstantial evidence to show that it did not result from ascospores.

The paper was discussed by Messrs. Bolley and Brewer.

Papers upon the program by L. H. Bailey, W. W. Rowlee, D. T. Durand, C. V. Riley and B. T. Galloway, in the absence of the authors, were read by title.

Mr. Britton presented his resignation as vice-president of the Club for the coming year, on account of contemplated absence in Europe, which was accepted, and D. C. Eaton was elected to fill the vacancy.

The Club then adjourned *sine die.*

Proceedings of the Madison Botanical Congress.[1]

WEDNESDAY, AUGUST 23, 10 A. M.

The Congress was called to order in the Physical Lecture Room of Science Hall by Dr. J. C. Arthur, Chairman of the Committee on Arrangements.

The chairman gave an account of the origin of the present Congress, and the steps which had been taken to secure a full attendance, not only of American botanists, but also an adequate representation of foreign ones.

A committee consisting of Messrs. Bessey, Britton, MacMillan, Tracy and Davis, was appointed to nominate officers for the Congress, and a recess was taken until the committee was ready to report.

Upon reconvening the committee first offered the following resolution pertaining to the official name of the Congress, which was adopted without discussion:

"*Resolved*, that, inasmuch as the attendance of European botanists at this meeting has fallen much below the expectation of the organizing committee, so that the desired international character of the assemblage has not been realized, the name of the meeting be The Madison Botanical Congress."

The committee then presented the following nominations for the officers: For president, Edward Lee Greene, of Berkeley; for vice-presidents, Henry L. de Vilmorin, of Paris, and Lucien M. Underwood, of Greencastle; for secretaries, J. C. Arthur, of LaFayette, F. V. Coville, of Washington, and B. L. Robinson, of Cambridge; for treasurer, Charles R. Barnes, of Madison.

As Prof. Greene was not a duly qualified member of the Congress at the time, his name was withdrawn, and the other other nominations were unanimously confirmed. Subsequently his name was again presented for president and he was unanimously elected.

M. de Vilmorin presided during the remainder of the morning session.

A communication from the International Commission upon Nomenclature was read by the presiding officer, and was referred to the three American members of the International Commission.

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[1]As the report of the proceedings is to be published in full as soon as possible only an abstract is here given.—EDS.

A printed letter from Dr. Otto Kuntze, a copy of which had been handed to each member of the Congress upon registration was then presented, and was also referred to the American members the International Commission. The matter of the nomenclature of systematic botany being thus introduced to the Congress, it was voted that, inasmuch as the Congress did not possess the international character which had been hoped for, and could not therefore legislate upon questions of nomenclature, it should not further consider the subject.

A series of topics were presented by Secretary Arthur which had been suggested for the consideration of the Congress by various botanists, both American and foreign, a part having already been printed in the preliminary circular of the Committee of Arrangements.

The following committees were appointed to consider the topics named and to report at the next session of the Congress:

1. On the Nomenclature of Plant Diseases: B. D. Halsted, W. T. Swingle, and L. R. Jones.

2. On the Terminology of Anatomy and Morphology: D. H. Campbell, Conway MacMillan, and C. R. Barnes.

3. On the Terminology of Physiology: J. C. Arthur, W. T. Swingle, and A. S. Hitchcock.

4. On the Nomenclature of Horticultural Forms: W. Trelease, H. L. de Vilmorin, and B. L. Robinson.

5. On Bibliography: C. R. Barnes, N. L. Britton, and A. B. Seymour.

The attention of the Congress was called to the loss sustained by the botanical world in the death of Alphonse de Candolle, and George Vasey. H. L. de Vilmorin and F. V. Coville were appointed a committee to draft resolutions on the death of Alphonse de Candolle. N. L. Britton and C. E. Bessey were appointed a committee to draft resolutions on the death of George Vasey.

The Congress then adjourned until Thursday morning at ten o'clock.

In the afternoon, at two o'clock, fifty members assembled at the entrance of Science Hall, where carriages were taken for the excursion to Lake Wingra provided by the Local Committee of Arrangements. The afternoon was spent in examining and collecting specimens of the flora of the marshes, the dry morainic hills, and the edges of the lake. The trip presented an exceedingly varied flora which proved of much interest to those who participated in the excursion.

THURSDAY, AUGUST 24, 10 A. M.

The session was called to order by Vice-President Underwood, who, upon the election of E. L. Greene as President, surrendered the chair to him.

A telegram was read by Secretary Arthur from Prof. Wittmack, of Berlin, stating that his duties as judge at the Columbian Exposition prevented his attendance, and expressing his hearty good wishes for the Congress.

A committee on Geographic Botany, consisting of F. V. Coville, L. M. Underwood, and W. T. Swingle, was appointed to present this subject at the subsequent session of the Congress.

The report of the committee to draft resolutions on the death of Alphonse de Candolle was presented by M. de Vilmorin, adopted, and ordered engrossed, signed by the officers of the Congress, and transmitted to his family.

A committee on resolutions to express the appreciation of the members for the hospitality of the city was appointed: W. A. Kellerman, Miss S. M. Hallowell, and B. L. Robinson.

It was voted that discussion on the report of each committee be limited to one hour, and individual speeches to five minutes.

Report of the committee on Nomenclature of Plant Diseases was received.

The report was divided into seven sections, making suggestions for the limitation of common names now in use and the rules to be observed in applying new names.

After discussion by Vilmorin, Halsted, Swingle, Bessey, Jones, Britton, Arthur, Barnes, Kellerman, Seymour, Trelease, Coville, Carleton and Tracy, the report, after considerable amendment, was adopted.

A standing committee of seven, consisting of Messrs. Halsted, Swingle, Jones, Bessey, Kellerman, Atkinson and Galloway, was appointed to consider the subject and make a further report upon it.

A motion was passed directing all committees appointed by this Congress to report to Section G of the American Association for the Advancement of Science.

The report of the committee on the Terminology of Plant Physiology was read and partially discussed before the noon recess.

The committee reported four topics for discussion:

1. In reference to the terminology to be used regarding the several processes concerned in the use of food in building up the structure of plants. Four terms, assimilation, digestion, food, and the new term, photosyntax, were considered under this head.

2. The use of the terms fertilization, pollination, and fecundation. The committee recommended the abandonment of the term fertilization, and the use of the term pollination only to designate the transference of pollen to the stigma, and of fecundation to designate the union of the male with the female gamete.

3. The restriction of thd term *physiology* to the chemical and physical part of the general subject, and placing the remainder under the title *ecology*.

4. The limitation of species, varieties and forms. This topic was not discussed for want of time.

THURSDAY, AUGUST 24, 2 P. M.

The Congress was called to order with President Greene in the chair.

The unfinished business of the morning session, the discussion of the report presented by the committee on Terminology of Plant Physiology, was resumed.

As the work of this committee and the discussion which followed were only suggestive, the three members of the committee were empowered to select two others[1], and directed to report a tentative presentation of these matters as early as possible, in order that the substance of their report might be known before the next meeting of the American Association, at which time it is to be further considered.

The report of the committee on the Terminology of Plant Anatomy and Morphology was presented by Prof. MacMillan.

The committee recognized the great complexity of the matter with which they have to deal, and recommended to the Congress that a committee of five be appointed to take under more careful consideration the difficulties presented in the nomenclature of morphology. The committee brought to the attention of the Congress the difficulties in the present terminology respecting the structure of the stem, the use of the terms male and female as applied to the flower of phanerogams, and the terms used in designating the various parts

[1]MacMillan and Barnes were subsequently named.

of the sporophyte and gametophyte connected with reproduction. The committee also suggested the necessity of a general term to designate the product of fusion of two heterogametes.

After a brief discussion of the matters presented by the committee, its request for the appointment of a committee of five was concurred in. The original committee was continued, and Drs. Farlow and Thaxter were added to their number.

The report of the committee on the Nomenclature of Horticultural Forms was presented. The committee recommended:

1. That the nomenclature of the species and natural varieties used in forestry and decorative gardening should be treated by horticulturists precisely as they would be treated by botanists if found growing wild, and that they should therefore be subject to whatever rules by international agreement are adopted for general botanical nomenclature. Pending the adoption of such a code of rules, however, the names used in Nicholson's Dictionary of Gardening, so far as they go, should be used. In cases where Nicholson is insufficient, the Kew Index, now in course of publication, should be followed so far as it goes. In case of the displacement of familiar names these should be retained in parenthesis until both dealers and purchasers have become familiar with the change. 2. The nomenclature of florists' races and forms, as well as the more numerous artificial, and more or less transient forms of the fruit grower, vegetable gardener, and farmer, should be conducted on quite different lines from that of natural species and varieties, and all names used for such forms should be in the vernacular. Phrases should not be employed as names, and all such vernacular names should be limited to one, or at most two, words, avoiding high sounding or bombastic names, as well as those which have already been relegated to the list of synonyms. Priority of naming these forms should be recognized. Varieties and forms transferred to a country possessing a different language from that in which they were first named may be renamed, in case the name cannot be transferred directly to the language, the new name conforming so far as possible to the form and sense of the original name, and citing it as a synonym. For use in trade catalogues the names adopted in the official lists of various national societies should be adopted.

After brief discussion the report of the committee was adopted.

The report of the committee on Bibliography was then presented.

The committee make the following recommendations:

1. The publication of a current bibliography of American botany, comprising (*a*) a catalogue of papers by authors, (*b*) a catalogue of journals, (*c*) a list of acceptable abbreviations of authors' names; (*d*) an index of species, both new and old.

2. Rules for citations, of which the following may be taken as illustrative both of matter and typography:

Ramann, Waldbeschädigungen durch Flusssäure. Forst. Zeits. **2** : 245. Je 1893.

Fuligo septica.

Rosen, Beiträge zur Kenntniss der Pflanzenzellen. Beitr. Biol. Pfl. **6** : 247. *pl. 2. f. 5.* 1892.

Tulasne, Les Urédinées et les Ustilaginées. Ann. Sci. Nat. Bot. IV. **2** : 108. 1854.

Bolley, Prevention of potato scab. Bull. Exper. Sta. N. Dak. 9 : 27. 10 Mr 1893.[1]

The report was discussed at length by the Congress and was referred to a standing committee of five with power to act. This committee consists of Barnes, Seymour, Britton, Hitchcock and Mrs. A. F. Stevens. It was evidently the wish of the Congress to have the matters discussed in the report of the committee settled upon as early as possible, in order that the various indexes which are now in course of preparation or publication might conform to some general scheme of typography and citation.

A committee consisting of Bessey, Britton, and MacMillan, was appointed to bring before the Congress a proper memorial regarding the exposure of the United States National Herbarium to loss by fire.

The report of the committee on the death of Dr. Vasey was read, adopted and ordered engrossed, signed by the officers of the Congress, and transmitted to his family.

The report of the committee on Geographic Botany was presented. The short time for consideration at the disposal of this committee enabled it only to present in a very informal

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[1]Number of part, heft, fascicle, etc., is only to be given when it stands alone. It replaces the volume number but is printed in ordinary face type.

manner the topics which should be considered at length by a standing committee. After a brief discussion of the points reported, the present committee was appointed to follow up the question and prepare a report, to be submitted to section G of the American Association.

The treasurer of the Congress reported receipts from dues, and expenditures for printing, postage and translation, leaving a balance on hand of $1.45. The report was approved.

Question was raised in regard to the publication of the proceedings of the Congress. Mr. Barnes announced that the amount of money which was raised for the entertainment of the A. A. A. S. would probably be in excess of their expenditures, and thought it probable that a sufficient sum would be granted by the Local Committee to provide for publishing the proceedings of the Congress. The secretaries were therefore authorized to prepare the matter for publication and have it printed, the members of the Congress to assume the remainder of the expense beyond that which may be provided for by the Local Committee of Arrangements.

The report of the committee on the National Herbarium was read. The report points out the unsafe condition of the present building in which the Herbarium is located, its unusual exposure to loss by fire, and the valuable character of the collections which are contained in it, and urges that steps be taken to provide an adequate and fire-proof building for its reception.

It was directed that the memorial be engrossed, signed by the officers of the Congress, and copies transmitted to the Secretary of Agriculture, the chairman of the committee on Agriculture in the House, and the chairman of the committee on Appropriations in the Senate, of the United States Congress.

The report of the committee on Resolutions was read thanking the citizens of Madison for their hospitable entertainment, and extending thanks to Dr. Otto Kuntze for the trouble and expense which he had incurred in providing this Congress with unusual facilities for considering the question of nomenclature of taxonomy.

The Secretary of the Local Committee invited the members of the Congress after adjournment to a moonlight ride upon Lake Mendota. The invitation was accepted by about sixty, who thoroughly enjoyed the two hours excursion.

At the close of the afternoon session the Congress adjourned *sine die*.

BRIEFER ARTICLES.

Botany at the World's Fair.—There is no separate display illustrating the science of botany at the World's Columbian Exposition. What good might have resulted from an adequate setting forth of the history, development, economic importance, apparatus and methods of modern botany can only be imperfectly surmised. The opportunity to let the public, as well as their co-laborers, know what the 3,000 persons who devote their energies to this science are accomplishing has not been seized.

There is, however, considerable material scattered through the Exposition of interest to botanists. But it is so widely separated, and in the main so difficult to find, that it is likely to be largely missed by those who would receive the most benefit from the display. The following brief account may be an aid to visitors, but it is necessarily imperfect. Several days were devoted to securing the data for the article, and yet the writer has reason to believe that many interesting and praiseworthy exhibits of a botanical nature were overlooked. He is also aware that important details could have been added about those seen, and must offer as an excuse for their absence the difficulty which one meets as a rule in securing information. Very few of the exhibits are accompanied by adequate information, sometimes they are entirely unlabeled, and as a rule the attendants, if they can be found, can add little, if anything.

The largest herbarium shown is that of the Botanical Division of the U. S. Department of Agriculture. This consists of several thousand mounts arranged in a large case, illustrating the very satisfactory and complete method in use in the Division. It includes flowering plants, vascular cryptogams and lichens, and is purely a scientific exhibit, without even a single sheet with its mount exposed to attract the attention of the public. It is situated near the northeastern corner of the Government Building.

In the gallery of the Horticultural Building under the dome are a number of excellent collections. The Montana State Commission display the state flora upon two handsome oak wall counters with heavy mirror-glass backs and a wide shelf above. There are fifteen ingeniously constructed portfolios, containing over 1,000 specimens, prepared by Prof. F. D. Kelsey, who has recently removed to Oberlin, Ohio. Some material was contributed by R. S. Williams, of Great Falls, Mont. One additional portfolio of specimens was furnished by Mrs. J. E. Light, and two more by Mrs. L. A. Fitch, who also displays some herbarium specimens on the wall of the science room in the Woman's Building. Ten large frames containing bouquets of dried flowers, prepared by Emil Starz, complete the display.

The Wisconsin State Horticultural Society shows twenty portfolios of plants mounted on blotting paper, and very imperfectly named. The preparation of this collection was evidently entrusted to wholly incompetent hands.

The Kentucky exhibit is mounted on herbarium sheets and placed under glass in swinging frames, as are many of the others yet to be mentioned. It was prepared by Prof. H. Garman and Mr. J. S. Terrill, and is classified as forest trees, grasses, ferns, and wild plants. Miss Sadie Price, of Bowling Green, Ky., exhibits some 500 pencil sketches of Kentucky plants, in part admirably colored, in connection with the preceding.

The Oregon exhibit, prepared by Drake and Gorman, is a large and interesting one, particularly notable for its handsome mounting, the swinging frames being supported by massive oak standards.

Miss Nettie Palmer, of Edison Park, Ill., shows a large collection, well mounted in swinging frames.

Mrs. S. B. Walker, of Castle Rock, Colo., has an interesting collection of about 500 specimens in swinging frames, although not fully named, and also a case of gift articles decorated with pressed flowers.

The Missouri Commission shows over 1,600 specimens, collected largely by B. F. Bush. They are displayed in white frames, which do not prove as pleasing as the oak frames chosen by most exhibitors.

The next largest number of herbaria are brought together in the science rooms of the Woman's Building. In this place Alida P. Lansing shows 1,100 specimens of Colorado plants in swinging frames. A common fault of this method of display is here very marked. The central frame work is not sufficiently rigid to support the heavy load of frames without sagging, and in consequence the frames swing strongly in one direction, making it very unpleasant to examine the specimens.

The Montana flora is illustrated by over 400 specimens, collected by various women of the state, and handsomely mounted in swinging frames, supported on a massive column with carved capital.

There are a hundred large sheets of Brazilian ferns mounted in swinging frames, collected by Mrs. James Watson Webb in 1867–68.

Mrs. A. M. Croley, of Tilsonburg, Ontario, Can., shows a large collection of ferns from all parts of the world. The sheets are loosely placed in wall cases.

Good herbarium specimens of Mexican plants, but not fully named, are distributed loosely in a large wall case. Neither the name of collector nor exhibitor is given.

A collection of red sea-weeds is also shown in these rooms, but no information about them could be obtained.

In the Mexican exhibit in the west gallery of the Liberal Arts Building is a collection by F. Altamirano of the National Medical Institute. The specimens are mounted on standard herbarium paper, and arranged in genus covers. They are intended to be placed in five shelf cases imitating finely bound books, which accompany them. A few sheets are displayed loosely in the show case.

In the Agricultural Building, the Colorado pavilion contains a collection of fine large specimens of grasses in swinging frames, from the State Agricultural College.

The Minnesota pavilion has over 170 oak frames filled with herbarium sheets of grasses and forage plants, disposed about the posts and desks.

In the exhibit of Agricultural Colleges and Experiment Stations, in the south-western corner of the same building, there is a small herbarium case of about twelve pigeon-holes containing mounted specimens, also about 100 sheets of Scribner's American grasses in swinging frames, and about fifty of Halsted's American weeds placed behind glass on partition walls. This exhibit also includes a most interesting display of plant diseases, by means of dried specimens, drawings, often colored, and outline maps giving distribution, mounted upon herbarium sheets, and placed behind glass upon partition walls. Diseases of garden crops and fruits comprise 112 sheets, prepared by Prof. S. M. Tracy, diseases of cotton and carnations, twenty-eight sheets, prepared by Prof. Geo. F. Atkinson, diseases of grasses and grains, sixty-six sheets, prepared by Prof. L. H. Pammel and Prof. H. L. Bolley, and the mildews of plants, forty-seven sheets, prepared by Prof. S. M. Tracy.

In the Washington State Building 150 swinging frames ranged along the wall of the south wing display 1,200 specimens of the state flora, prepared by Louis F. Henderson. The labels for the most part give considerable information regarding the occurrence of the species, and in this respect it is one of the best herbaria shown.

The exhibit of the Michigan Agricultural College, in the Liberal Arts Building, and of the Illinois University in the Illinois State Building each contains a tall pigeon-holed case partly filled with specimens, illustrating the construction of herbarium cases and the formation of an herbarium.

In the German exhibit in the Liberal Arts Building are two volumes by Hieronymus and Pax entitled "Herbarium Cecidiologicum," being exsiccati of galls, also a volume of Paul Hennings' "Phycotheca

Marchica" bearing date of 1893, being fifty specimens of dried fresh-water algæ, and also a volume of handsome exsiccati illustrating Mr. Hennings' methods of preparing succulent flowering plants and fleshy fungi for the herbarium, which every collector and preparator should be sure to see. There is also here an interesting historical exhibit, probably the only one in the Exposition relating to botany, showing the way in which J. J. Rousseau kept his specimens. It includes a vellum-bound volume, about eight by ten inches, in which the plants are fastened with strips of gilt paper, some loose sheets of plants, a manuscript catalogue of his collection, and his list of signs used as abbreviations.

It is a significant fact that in only three places in the great Exposition does one run across the placard "Botany," one of these being at this place in the German exhibit, where some space is set apart for botany in the portion devoted to the German universities, one being in the exhibit of the Agricultural Colleges and Experiment Stations, where a botanist is constantly in attendance, and one in the University exhibit in the Illinois State Building.

The German botanical exhibit is largely from the Royal Botanical Museum of Berlin. Beside the objects already mentioned there are seven wall cases about twenty inches wide by four feet high filled with (1) the plants that ants inhabit, (2) principal German hymenopterous galls, (3) phytopterous galls, (4) dipterous galls, (5 and 6) large fungi from the German colonies in Africa, and (7) fragments from the tombs of Egypt, about 1700–1200 B. C., including wheat and barley grains, tubers of Cyperus, palm seeds, stolons of mint, and wreaths made of the leaves of Mimusops and petals of Nymphæa. The Botanical Institute of Breslau shows eleven photographic views of the grounds and some printed volumes. The Institute of Vegetable Physiology of Berlin shows colored models of the several developmental forms of Puccinia, Claviceps and Peronospora from designs by Dr. W. Zopf, and of Marchantia, pine seeds and seedlings, Primula flowers, structure of pine wood, etc., from designs by Dr. Carl Müller, all made by Brendel of Berlin. The same institution shows large microscopic sections of wood, and microscopic mounts showing the effect of light and gravity upon the growth of mycelium, prepared by Prof. L. Kny, and also a set of Kny's colored wall charts. The Botanical Museum of Kiel shows a dredge used for marine algæ by Dr. Reinke, and a published volume of his results.

It will be seen that while this is an interesting exhibit, it is not in any respect representative of the present state of botany in Germany.

On the same floor, which is a second limited gallery, reached by

stairways in the German section of the western gallery are models of Claviceps and Puccinia made by Paul Osterloh, of Leipzig, and colored wall charts with black back ground of flower dissections, published by Frommann and Morian, of Darmstadt (Fred. Buch, 1138 Milwaukee Ave., Chicago, agent).

A very large series of the Brendel models is shown by the manufacturer among the school supplies in the German section in the first gallery.

In the space devoted to botany in the exhibit of Agricultural Colleges and Experiment Stations in the Agricultural Building will be found, beside the collections already referred to, a fine set of thirty vials containing root tubercles of different species of Leguminosæ from the virgin soil of North Dakota, prepared by Prof. H. L. Bolley, a set of Halsted's weed seeds in vials, a full-sized model of the famous experiment conducted by President Clark, of the Massachusetts Agricultural College, in which a squash was made to lift a weight of 5,000 pounds as its size increased by growth, and also a model of the present vegetation house and laboratory building of that institution. There are a number of standard seed testers shown by the North Carolina experiment station, a universal stand for photographing flowers, fruits, microscopic preparations, etc., devised by Prof. F. L. Scribner, sixty-two bromide enlargements, 12 by 14 inches, from photographs by Prof. L. H. Bailey, illustrating the effects of crossing the egg-plant, tomato, corn, cabbage, cauliflower, turnip, squash, gourd, coleus, phlox, etc., and preparations by Prof. F. H. King showing the distribution in the soil of the roots of common cultivated plants.

In the same exhibit is a case devoted to physiological apparatus exhibited by J. C. Arthur, showing twenty-three pieces, a few of which are imported, and a part made from original designs. It appears to be the only display illustrating vegetable physiology in whole or in part in the Exposition.

Photographs of thirty-four American and forty-eight foreign botanists are shown at this place. A still larger number, however, are shown in the exhibit of the Michigan Agricultural College, in the Liberal Arts Building, where photographs may also be seen of the grounds and botanic garden of that institution.

Some excellent photographs, 4 by 5 inches, of plant galls and the larger fungi, are exhibited by Miss Cora H. Clark, of Jamaica Plain, Mass., in the Science Room of the Woman's Building. There are many fine bromide enlargements of views in the Botanic Garden of Sidney, New South Wales, in the gallery under the dome of the Horticultural Building, and also five views of the botanical garden of the Royal University of Tokio, in the same room.

Photographs of the laboratories and of students performing various experiments are shown in the exhibit of Purdue University in the Liberal Arts building, giving a very complete idea of the facilities of this institution for teaching botany, especially when taken in connection with the apparatus shown in one of the cases.

Harvard University in the same building shows a case of the handsome glass models of flowers from the Ware collection, which now numbers 400 species, and will eventually number 1200 species or more; also a case of fibers, handsomely mounted; 20 fine illustrations, 10 by 12 inches, very faithfully colored, from a forthcoming work on North American fleshy fungi by Prof. W. G. Farlow; and a set of the published writings of Dr. Gray.

The Illinois University has, in the State Building, the most complete exhibit to illustrate the teaching of botany to be found in the Exposition. It contains a working desk for an undergraduate student and one for an investigator, a series of microscopes formerly used and a series now in use, sets of microscopic slides, photomicrographic enlargements, apparatus for photomicrography, sets of reagents and stains, a very full bacteriological outfit with living cultures, an herbarium previously referred to, museum specimens, a set of reference books, card catalogues, and many other things that can not find place here. Across the aisle in the display made by the Experiment Station of that institution is a long case showing diseases of cultivated plants, and a collection of seeds of wild plants.

The Division of Vegetable Pathology in the Government Building makes a very creditable display of its work, showing wax models of diseased fruits and leaves, large photographs to illustrate treatment, bacteriological and microscopical apparatus, and a set of slides revolving under a microscope, which last proves a very attractive feature to the public.

The agricultural schools of France are represented in the Agricultural Building near the southwestern corner. Here one will see models of grape seeds, each about two inches long, showing twelve types of grape seeds, and plates illustrating grape diseases, shown by Prof. Viala, of the school of Montpellier; a set of twenty-four specimens illustrating plant diseases, a wall chart of fungi, and a record of important discoveries made at this school, dating from 1807 when Prevost ascertained the nature of the bunt of wheat and proposed the copper sulphate remedy, later discoveries being made by Tulasne, Duchartre, Millardet and Prillieux, the exhibit being made by Prof. Prillieux, of the National Agricultural Institute; and finally seven student's herbaria of about one hundred specimens each, from the school at Sartilly.

If one is interested in fibers, the Exposition offers many opportunities for studying them. One should especially see the exhibit of Paraguay in the Agricultural Building and of the Section of Fiber Investigation in the Government Building.

A very beautiful exhibit of skeletonized leaves and seedpods is shown by Mrs. A. M. Croley in the science room of the Woman's Building

A fine large set of fungi of more than usual interest is shown by C. H. Peck, of the New York State Museum, in the gallery under the dome of the Horticultural Building. Models of fungi rather crudely colored and fancifully arranged are shown by the division of microscopy in the Government Building.

There are numerous extensive displays of medicinal plants in jars, often accompanied by herbarium specimens, of which the best are shown in the Government Building by the Department of Agriculture, in the Agricultural Building by Paraguay, in the western gallery of the Fine Arts Building by Mexico, and in the Costa Rica building.

The Forestry Building contains much of interest to botanists. The displays made by New York, North Carolina, Ohio, and Russia should be especially examined. The last has a new device for showing herbarium specimens of trees.

There are many collections of grasses tied up in bunches. Such may be seen in the western wing of the Illinois Building, in the Division of Botany in the Government Building, and in the Wyoming and North Dakota pavilions in the Agricultural Building. The latter is especially complete as a state exhibit, containing, beside the sedges, 124 species of true grasses belonging to forty-nine genera, of which eighty-eight species are native of the state. It is well displayed in heavy oak cases.

Large and interesting displays of bacteriological apparatus are made by the German universities in the gallery of the Liberal Arts Building, the U. S. Hospital Service at the south end, and the Bureau of Animal Industry on the east side of the Government Building. The last two also maintain laboratories and show many kinds of living cultures as does also the bacteriological laboratory for milk and butter in the exhibit of Agricultural College and Experiment Stations in the Agricultural Building.

A very large number of paintings in water colors of the flora of Australia, each about eighteen by twenty-two inches, is displayed on the walls of the New South Wales Building. The artist is Mrs. Rowan, who is expected at the fair the latter part of August. The collection is a unique and beautiful one, and is for sale at a valuation of $25,000.

At the west entrance to the central pavilion of the Art Palace is a

large bas-relief in plaster of Linnæus, by Jacob Eriksson, of Stockholm. The figure is life size, and shows the father of botany leaning against a tree admiring a wild flower in his buttonhole. The pose is admirable, and the expression just what a person familiar with the character of the great naturalist will regard as best portraying his nature. In the arch above is crouching Flora with an armful of flowers. The piece is valued at $1,500. It has been secured by a Swedish gentleman of Chicago and will be presented to the Chicago Art Institute at the close of the Exposition. The sculptor is now in Paris executing the same piece in marble to be placed in the Museum of Stockholm.—J. C. A.

EDITORIAL.

All botanists who wish to promote the interests of this vast science in America (and who does not) must feel gratified at the outcome of the gatherings of botanists in the latter part of August at Madison. For almost two weeks daily meetings were being held with which botanists were more or less closely identified. Numerous papers of scientific importance were presented at these gatherings. Section G, the new section of botany colonized from section F, was one of the busiest of the sections. Thirty-four papers were presented before it, and only thirty-five before the long established and popular section of anthropology.

But our gratulation is based not so much on the number and character of these papers as upon the amount of work undertaken not for selfish ends but for the purpose of advancing the interests of botanical research and instruction, and especially upon the unanimity with which all these schemes were undertaken. This spirit of cordial coöperation is one of the most promising evidences of the good-fellowship which seems to characterize botanists more than some other scientific groups we could name. The manifestation of it at these Madison meetings has been even more marked than at Rochester last year when we commented upon it. It is to be hoped that the feeling here is only the precursor of a similar sentiment of international scope.

The sustained interest in these annual gatherings is also noticeable. Although the attendance upon the American Association as a whole fell far below expectations, the registration scarcely reaching 300, the number of botanists present was almost if not quite as great as at Rochester. It is safe to say that the number of botanists in Madison did not fall much short of one hundred.

Two matters of special importance with reference to the teaching of botany were taken in hand by section G. At the request of the committee on program, Professor MacMillan had prepared a paper on the present condition of the teaching of botany in colleges and universities. The facts presented, though only a summary of the information collected, proved to be of such interest that Professor MacMillan was invited to continue his work in this direction; and the Council approved the resolution sent to it by section G, asking that the Commissioner of Education print the report as a Circular of Information. The section also asked the Council to appoint a standing committee on instruction in botany in secondary schools, which was done. We hope this committee will be active.

The bogy of taxonomic nomenclature was not obtrusive enough to trouble the gentlest histologist. The Botanical Club increased its committee on nomenclature by adding to it Messrs. Trelease and Greene, and referred the minor questions to the committee with power. The Check List which the committee has prepared was ordered printed and enough copies were subscribed for to insure the early accomplishment of this work. The Club also endorsed by a large majority the plan for the formation of a restricted botanical society, to membership in which amateurs and the younger men might look forward as a distinct honor. For it is to be only after a man has won his spurs by worthy work that he can become a member.

In spite of the fact that the attendance of foreign botanists at the Congress was almost nil this gathering must be counted a distinct success. It has at least taken the initiative in much important work relating to usage, and if the committees follow up the work as some of them will undoubtedly do, we may look for some good results. But even if none of them does what it was appointed to do, the discussions which occurred upon the reports of the various committees on program cannot fail to be of much help to those who participated in them or heard them. It is to be noted that these discussions were peculiar in that they were based upon the working knowledge of the members of the congress, and not upon the research of one who had investigated the subject thoroughly. All therefore stood practically upon the same plane. Whatever disadvantages that method may have had, it had the distinct advantage of opening the mental eyes to one's limitations, and of seeing what the workinge knowledg of some of the most active American botanists amounted to. The showing was creditable. We should have had no occasion to be ashamed had Germany and England and France been well represented. Moreover the wide range of topics discussed must have had the effect of increasing one's appreciation of the scope and complexity of the science of which we delight to declare ourselves disciples, though each can know only a small part of it.

CURRENT LITERATURE.

A new text-book of botany.

The last (fourth) edition of Sachs' admirable text-book, a work which marked a distinct era in the teaching of botany, appeared in 1874, and owing to the rapid advances of the science, great need has been felt for some time for a revision of the work or of a new work to take its place. The author himself, having long since abandoned all hope or even desire to revise the work in its original form, published a work about ten years ago covering the physiological portion, and somewhat later Prof. Goebel wrote a work covering the part upon special morphology. These greatly enlarged portions still left a strong demand for a general text book of moderate size. The publisher, to whom the botanical public is greatly indebted for bringing out many works of the highest merit, made a special effort in 1890 to secure a new edition of the text-book. He urged the task upon Prof. A. B. Frank of Berlin, who was in many ways admirably fitted to undertake it. The offer was finally rejected upon grounds substantially the same as those that had influenced Prof. Sachs long before: i. e., that even the plan of the work needed changing, making it equivalent to writing a new treatise.

A new treatise, however, was at once undertaken, and to-day we have in Frank's *Lehrbuch der Botanik*[1], a work that presents the general subject of botany as nearly along the lines laid down by Sachs' text-book as could probably be attained at the present time, and yet presenting the freedom of treatment and freshness of matter of a thoroughly independent work. It is in two volumes, the first containing anatomy and physiology and the second, morphology and classification. A single index is made to serve for both. Some of the illustrations have already appeared in Sachs' textbook, but many also are new.

A feature of the work that is indicative of the change that has taken place in the recent relative development of the main departments of botany, is the comparatively large space given to physiology. Only one third of the first volume is devoted to the discussion of cells and tissues. This portion of the work is well done, but presents no specially new features. The remaining two thirds of the volume are devoted to physiology and it is in this part that we find the most characteristic and interesting portions of the author's labor.

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[1] FRANK, A. B.:—Lehrbuch der Botanik nach den gegenwärtigen Stand der Wissenschaft. Vol. I, Zellenlehre, Anatomie und Physiologie. 669 pp. 227 illust. 1892. Vol. II, Allgemeine und specielle Morphologie. 431 pp. 417 illust. 1893. Leipzig, Wilhelm Engelmann. Roy. 8vo. Marks 29.

Physiology is defined as the physics and chemistry of living objects. The external conditions and agents, such as heat, light, electricity, gravity, water, oxygen, contact of solid bodies, and symbiosis, are first taken up. The last topic occupies twenty pages, and is a feature of the work that every botanist will desire to examine. Symbiosis is distinguished as antagonistic (parasitism) and mutualistic. The latter is again separated into disjunctive (illustrated by the reciprocal benefits in insect pollination) and conjunctive (illustrated by lichen symbiosis, ectotropic and endotropic mycorhiza, and by the presence of algæ within some higher plants). Several well drawn figures illustrate the ectotropic mycorhiza of beech and hornbeam, and of the endotropic mycorhiza of Ericaceæ, Orchidaceæ and Leguminosæ.

Under physical properties and phenomena the movement of protoplasm, water and gas, the mechanical, optical and electrical peculiarities, and the many phases of growth and movement are very fully treated. It will be remembered that Frank originated the terms heliotropism and geotropism, which apply to two of the most interesting characteristics of plants.

The chemical portion of the subject includes respiration, fermentation, the numerous classes and kinds of vegetable compounds, and the extensive topic of nutrition. The last has made wonderful development in the past few years, and the author having been one of the most active of investigators in this line, makes this one of the most interesting portions of the work.

The physiological part of the first volume closes with a chapter on reproduction, heredity, etc.

The second volume opens with fifty pages of general morphology, and the remainder is devoted to special morphology and classification.

The following outline will give the main features of the classification adopted by the author.

I. THALLOPHYTA:
   1. Myxomycetes.
   2. Schizophyta (includes nostoc, oscillaria, etc., and bacteria).
   3. Peridinea (small, mostly marine, flagellates).
   4. Diatomaceæ.
   5. Algæ (in five classes, one being Characeæ).
   6. Fungi (in three classes).

II. ARCHEGONIATÆ:
   1. Muscinei.
   2. Pteridophyta (in four classes, one entirely fossil).

III. PHANEROGAMÆ:
   1. Gymnospermæ (in four classes, one entirely fossil).
   2. Angiospermæ.

Lichens in this classification are distributed under the discomycetous, pyrenomycetous and basidiomycetous fungi, the larger part falling under the first. Angiospermæ are divided into only two subgroups: Archiclamydeæ and Sympetalæ, the former including the Polypetalæ and most of the Apetalæ, and the latter the Gamopetalæ, as heretofore classified.

The citations of literature throughout the work are grouped at the end of each subject. There are three unusually full indexes, one of illustrations, one of subjects and one of plant names.

The work is a valuable addition to the present list of textbooks of botany. One can only regret that it is not also published in the English language.

NOTES AND NEWS.

Carl Friedrich Nyman, the author of the useful Conspectus Floræ Europææ, died recently in Stockholm.

Dr. Dietrich Brandis, the well-known forest botanist, has been called to a professorship in the University of Bonn.

Professor A. von Nordenskiöld, of Stockholm, has been elected a member of the Academy of Sciences at Paris to fill the place made vacant by the death of Alphonse DeCandolle.

The editorial staff for the new "Standard Dictionary of the English Language," shortly to be published by Funk and Wagnalls Co., New York, includes the following botanists: F. H. Knowlton, Erwin F. Smith, David White and W. T. Swingle, all of Washington, D. C., in charge of botany, and A. A. Crozier in charge of pomology.

The committee of ten selected by the Botanical Club met on Wednesday morning, August 23, 1893, and, having previously prepared their first ballots proceeded to elect fifteen additional persons to become charter members of the American botanical society. Twelve were elected on the first ballot and the remaining three on the second. The following are the names of the twenty-five charter members:

Arthur, J. C.	Coulter, J. M.	Robinson, B. L.
Atkinson, G. F.	Coville, F. V.	Sargent, C. S.
Bailey, L. H.	Eaton, D. C.	Scribner, F. L.
Barnes, C. R.	Farlow, W. G.	Smith, J. Donnell.
Bessey, C. E.	Greene, E. L.	Thaxter, R.
Britton, N. L.	Halsted, B. D.	Trelease, W.
Britton, E. G.	Hollick, A.	Ward, L. F.
Campbell, D. H.	MacMillan, C.	Wilson, W. P.
		Underwood, L. M.

BOTANICAL GAZETTE.

OCTOBER, 1893.

The fructification of Juniperus.[1]

JOHN G. JACK.

WITH PLATE XXXIII.

With rare exceptions most of the plants of our American flora ripen their fruit during the same season in which the blossoms are produced. Among ligneous plants in North America the only noted deviations from this rule of nature are found among the true pines, or genus Pinus as it is now limited and defined by most systematists, and in that section of the genus Quercus classified under Melanobalanus or black oaks.

These trees are monœcious and blossom in the spring or early summer, the young fruits being only partially or slightly developed at the end of the first season's growth and not ripening until the autumn of the second year. The sequoias of California are also said to be biennial fruited, and it has been stated that the cones of several species of Pinus require three seasons to arrive at maturity.

The witch hazel, *Hamamelis Virginiana* L., and the seaside alder, *Alnus maritima* Muhl., differ from these in only requiring one season of growth from the flower to the ripe fruit, for although the blossoming takes place in the autumn, the young ovary makes little or no growth before the following spring, and it becomes fully developed and ripe in the ensuing autumn when the plant is again in flower, so that just a year elapses between the time of flowering and the maturing of fruit; while among the black oaks and the pines, in this latitude, the time necessary for maturation approximates eighteen months, or two summers and one winter.

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[1]Read before section G, A. A. A. S., Madison Meeting, August, 1893.

Except the pines and sequoias, all of our other coniferous trees are commonly credited with being annual fruited, although various authors have distinctly stated that the junipers or savins are biennial fruited.

Dr. Asa Gray in his manuals leaves us to infer that the junipers are annual fruited, and so do Emerson,[2] and Chapman.[3]

Bigelow[4] says of the fruit of Juniperus communis that "it requires two years to arrive at maturity from the flower," but makes no observation as to J. Virginiana, so that it would be assumed to be annual fruited; and Wood[5] makes the same record.

Watson[6], in giving the characters of the genus Juniperus, states that the fruit only arrives at maturity in the second year, and Coulter[7] makes a similar note.

Dr. George Engelmann in his monograph[8] says: "The juicy strobil, galbulus, which we may for shortness' sake designate by the popular name of *berry*, matures like the fruit of the oaks and the true pines in the second year, but, unlike them, it attains almost its full size in the first autumn, when even the stony coating of the seed is pretty well formed; but it matures fully a year later. We often observe berries of both years, young and maturing ones, on the same stock; but where it bears only every other year, as conifers often do, fruit of one season and of one state of maturation only is found at one time."

So far as I have been able to examine into the subject, these instances are the only records by American writers where it is distinctly implied or stated that the fruit of Juniperus requires more than one season to arrive at maturity.

Quite a number of European authors record it as a peculiarity, although their testimony is conflicting. The point is not mentioned in some works which might be expected to refer to it.

Behlen[9] says of J. Sabina, J. communis, J. Oxycedrus, J.

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[2]Trees and Shrubs of Massachusetts.
[3]Flora of the Southern States.
[4]Medical Botany, III (1820).45; Fl. Bostoniensis, 1840, 399.
[5]Class Book of Botany, 663.
[6]Botany of California, II. 111,112.
[7]Flora of the Rocky Mountain Region, 429.
[8]The American Junipers of the Section Sabina, Trans. Acad. Sci. St. Louis, III (1877). 586.
[9]Bot. Handbuch, 1824. 269-275.

Virginiana, and others, that the fruit is ripe in the second autumn; and Antoine in his monograph[10] says that both the true junipers and those of the section Sabina take two years to mature fruit, while Carrière[11], in characterizing the genus, says the maturation is biennial, and in the description of our red cedar, Juniperus Virginiana, speaks of the fruit as ripening the second year.

Parlatore[12] says the galbulus ripens the second year. Nicholson[13] says of the genus as a whole: "Fruit berry-like, ripening the second year."

Among those who mark a variation within the genus in time of ripening of fruit we find that Spach[14] says that the maturation of the section Oxycedrus is biennial; of the section Sabina annual or biennial; and that the fruit of J. Virginiana ripens before the end of the same year after blossoming, but persists until the following spring.

Endlicher[15] says that the galbuli mature in the first or only in the second year.

Loudon[16] says of the berries of the common juniper, Juniperus communis, that "they continue on the bush two years;" and he further states[17] that the berries of Juniperus Phoenicea are not ripe "till the end of two entire years." In his summary of the specific characters of the Red Cedar,[18] Juniperus Virginiana, he says: "Flowering in May and ripening in October;" so that ne evidently counted it, like most plants, as maturing in the same season that it blossomed.

Boissier[19] divides the section Sabina into five annual and one biennial fruited species, but makes no comment as to the time required by the section Oxycedrus to mature fruit, four species of this section coming within the scope of his work.

In the course of my work at the Arnold Arboretum I have had occasion to specially notice Juniperus communis and J. Virginiana during the past three seasons, and the following

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[10] Die Cupressineen-Gattungen: Arceuthos, Juniperus und Sabina, 1857, 9, 35.
[11] Traité des Coniferes, 1867, 8, 44.
[12] De Candolle's Prodromus, xvi. *2* (1868). 475.
[13] Dictionary of Gardening, 1887. 211.
[14] Ann. des Sci. Natur. II. xvi (1841). 289, 292, 294.
[15] Genera Plantarum, Suppl. iv. *2*. 2. Vienna, 1847.
[16] Arboretum et Fruticetum Britannicum, iv (1854). 2491.
[17] See p. 2501.
[18] See p. 2495.
[19] Flora Orientalis, v (1881). 708.

observations may serve to settle this point about the fructification in regard to the only three species which occur east of the Mississippi River. As a rule, they are diœcious, but monœcious examples may sometimes be found.

As is well known, *Juniperus Virginiana* L. is one of the most widely distributed of our American trees, ranging in the east from the northern boundaries of the United States, to Florida, and westward to the Pacific coast.

In New England I find it is simply annual fruited, flowering about the latter part of April and maturing its fruit in the autumn of the same year. In examining specimens from other parts of the country, especially from the south, this characteristic of ripening in the same season seems to be constant. We find no green fruit on the plants in winter, and before spring the trees are often stripped of their ripe blue fruit by birds. The persistence of the fruit during winter and even through the following spring may have given rise to the impression that it was biennial. The galbulus is usually somewhat irregular, normally contains two seeds, and is composed of about three pairs of coalescing scales.

I have not been able to study living plants of *Juniperus Sabina*, var. *procumbens* Pursh., the only other eastern American species of the section Sabina; but, through the courtesy of correspondents, I have had fresh specimens at different stages. This species proves to be very distinctly biennial fruited, the large galbuli and the seeds ripening in the autumn of the second year. The galbulus, formed by the consolidation of six fleshy scales, in three pair alternately arranged, is usually more or less irregular instead of being perfectly round, and in the first season it attains three-fourths or four-fifths of its ultimate size.

The third and last of our eastern American species is the low-growing common juniper, *Juniperus communis* L., belonging to the section Oxycedrus, having three leaves in a whorl, and a native of the old world as well as the new. Very naturally, it has been much studied and monographed, and yet an important peculiarity of its fructification seems to have escaped notice. Instead of requiring only one year, as does Juniperus Virginiana, or two years, as is the case with Juniperus Sabina, var. procumbens, the fruit of Juniperus communis does not mature until the autumn of the third year after blossoming.

In the region about Boston this species generally blossoms from about the middle to near the end of May, or just about a month later than Juniperus Virginiana. The flowers appear in the axils of the leaves from well developed buds on the twigs of the previous season's growth.

The male flower, or catkin as it is sometimes called, is composed of five or six whorls of scales, three in each whorl, each scale usually bearing three or four anthers filled with globular slightly roughened pollen grains about one-fortieth of a millimeter in diameter.

The female flowers consist of three fleshy, tubular, pistil-like terminal organs, commonly considered as ovules, but whose position suggests scales, and by which term I shall provisionally refer to them. Outside of these and alternate with them are three obtuse, very short, thin, fleshy scales not noticeable at flowering time, and with the lower parts of their edges joined together and their inner surfaces connected near the base with the seed bearing scales. These are surrounded and protected by five or six whorls of pointed imbricated scales in alternate series of three like the leaves. When stripped of these outer scales the six inner ones, which ultimately form the seed and fruit, are hardly more than a millimeter in length; or, including the scaly covering, the whole length is nearly two millimeters. The upper ends of the three terminal fructiferous or seed bearing scales protrude beyond their scaly covering like three hollow pistils—they are called styles by Baillon[20] and some others—and diverge slightly outward from each other.

From each orifice there is exuded, when in perfect condition for fertilization, a minute globule of clear shining liquid which rests like an iridescent bubble on the tip and serves to catch the pollen and conduct it to the nucellus or ovule within.

After fertilization the tips of the tubular fructiferous scales seem less prominently exserted and except by a thickening around the base, no apparent growth takes place during the entire summer, so that by autumn or winter the little galbuli are still not much more than a millimeter long. In this condition they look like buds and probably have usually been mistaken for such.

During warm days early in the following month of May, in the climate of Boston, an appreciable increase in size is ap-

[20] Histoire des Plantes, XII (1892). 8.

parent, and a little later, or when the plants are again in good bloom, the year-old galbuli have grown to about four millimeters in length and nearly as large in diameter, the three fleshy enveloping scales having grown rapidly and become almost perfectly coalesced or consolidated around and above the three inner or seed-bearing scales, the outer protecting minute imbricated dry scales making no growth and being shoved aside and left at the base.

Growth and development are continued throughout this second summer and by the end of the second autumn the galbuli have attained to three-fourths or four-fifths of the ultimate size, and are still quite green without and within. The seeds are filled with soft milky immature albumen.

In the third spring and summer the albumen grows firm and solid, the process of hardening being gradual from the center toward the circumference, the differentiation taking place being quite plainly seen on making a cross section of the seed at the end of May or early in June. About the end of summer the fruits or galbuli begin to change color and assume the bluish or bluish-black color characteristic of maturity. The outer fleshy portion of the fruit changes from a green and hard texture to a soft mealy one, having a somewhat resinous sweet flavor. It is now, in the autumn of the third year from flowering, fully ripe and in a condition to germinate or be eaten by birds.

When not properly fertilized, or when otherwise imperfect or injured, the immature fruits often turn purplish and shrivel in the second season.

Some of the published figures of the fruit of Juniperus communis show the tips of more than three scales as forming the outer fleshy covering, another whorl of scales being represented with the tips showing around the sides of the galbulus. In fact, there are only three scales which combine to form the entire outer part of the fruit in this species; and at maturity their tips have become smooth and rounded, and of course are only to be noticed around the top or crown, leaving the sides perfectly smooth to the base. These scales at flowering time were not noticeable, being hidden, as already stated, beneath the outer leafy protecting scales.

I have not had enough or sufficiently fresh material to secure accurate data as to the length of time required to mature fruit among western species of Juniperus and those from

the Old World. Of course it is to be expected that Juniperus communis, which is indigenous in both Europe and Asia as well as North America, requires the same time to mature fruit in all regions. *Juniperus rigida* Sieb. & Zucc., of Japan, apparently also passes three seasons before arriving at maturity; but it seems hardly likely that all the species usually classed in this section, Oxycedrus, take so long before reaching full development. In the genus as a whole, probably a large proportion of the species ripen their fruits at the end of the second season; and there are others, besides Juniperus Virginiana, which mature their fruit in the same year in which they blossom.

It is almost impossible to determine these points with accuracy from ordinary herbarium specimens as they are generally collected, and, in making a study of the length of time required by the fruit of different species to arrive at maturity, herbarium material should be collected with special regard to this character; or, still better, the living plants should be carefully observed whenever possible.

For the accompanying plate and other assistance I am indebted to Mr. C. E. Faxon.

Arnold Arboretum, Harvard University.

Explanation of Plate XXXIII.—Fructification of *Juniperus communis* L. Fig. 1. Male branch with flowers. Fig. 2. Female branch, flowers and fruit. *a*. Flowers. *b*. Fruit, one year old. *c*. Fruit, two years old (May 25), not mature until autumn. Fig. 3. Male flower, enlarged. Fig. 4. Scale of male flower, exterior view enlarged. Fig. 5. Scale of male flower, interior view, enlarged. Fig 6. Female flower, enlarged. Fig. 7. Fruit one year after flowering, transversely divided, enlarged. Fig. 8. Fruit two years after flowering, transverse section, enlarged. Fig. 9. Seed, two years from flowering, showing resin glands on the back, enlarged.

Development of the embryo-sac in Acer rubrum.

DAVID M. MOTTIER.

WITH PLATE XXXIV.

A study of the development of the embryo-sac of *Acer rubrum* L. presents in itself nothing new or striking, but from the standpoint of comparative morphology it is not wholly without interest. This work represents only a part of a series of similar investigations to be made upon various angiosperms of both related and widely separated families.

Flowers of Acer rubrum in earlier stages of development may be obtained in winter and early spring, by removing the scales and fine silken hairs that enclose them in the bud. From buds taken in the latter part of March (the same condition may be found earlier), the ovules in the young female flower were in the stage of development represented in fig. 1.

In the apex of the nucellus will be found a cell much larger than the other cells, and with more densely stained contents. This is the mother-cell of the embryo-sac. At the time work was begun upon this subject I was unable to find flowers with younger ovules. The mother-cell, in all probability, arises from a single hypodermal cell, but as growth proceeds it soon becomes more deeply situated in the nucellus by the multiplication of the epidermal cells by tangential or periclinal divisions (fig. 2). A transverse section of the nucellus in this stage of development is shown in fig. 3, the larger central cell with large nucleus being the mother-cell of the embryo-sac. This cell which has now elongated considerably divides by a wall at right angles to its long axis (fig. 4). The upper cell divides again in a similar manner, so that there are three cells resulting from the mother-cell (fig. 5). The lower one of these three now enlarges gradually absorbing the two upper; its large nucleus soon divides, and the resulting nuclei move away from each other toward opposite ends of the cell (fig. 5). The further behavior of these nuclei is similar to that which obtains in all known embryo-sacs of angiosperms. The embryo-sac continually increases in size at the expense of the tissue of the nucellus immediately surrounding it.

The mature embryo-sac is broad at the micropylar end, but narrows gradually toward the antipodal end, which is occupied by the small antipodal cells (fig. 8). Here, as in almost all plants, one sees a considerable variation in the position of the endosperm nucleus. It may be close to the egg-apparatus (fig. 9), or more nearly midway between the ends, but always imbedded in the layer of protoplasm lining the interior of the sac, the central cavity of the sac being occupied by one or more large vacuoles. Here, however, the antipodal cells remain very small and their presence can be demonstrated only with considerable difficulty. They are soon absorbed after the embryo-sac is mature, the latter all the time increasing rapidly in size, especially if fertilization be effected.

One case was observed in which the three antipodal cells lay close together without cell-walls (fig. 10). In fig. 11, two naked cells may be seen with large vacuoles. These appeared to be undergoing disorganization.

The process of development in the embryo-sac of Acer rubrum is similar to that which takes place in few families of both monocotyledons and dicotyledons.[1]

It may be of interest to note that the pollen spores formed in the anthers of female flowers (fig. 12); though never becoming functional, develop normally. They are, as far as observation goes, almost precisely like those of the functional male flowers (fig. 13) with the two nuclei present which stain similarly to those of the functional spores. They are, however, smaller, one of the nuclei having a less definite membrane and the protoplasm consisting of a coarser reticulum, while the protoplasm of the functional pollen spores is of a more finely reticulated structure (fig. 13).

In female flowers, when the ovule has reached the stage shown in fig. 2, the four pollen spores have already been formed; the tetrads are, however, as yet enclosed by the wall of the mother-cell. Shortly after the flower opens these anthers shrivel and dry up.

The material for this study was fixed in a one per cent. aqueous solution of chromic acid, washed, stained *in toto* with alum cochineal, imbedded in paraffin, and sectioned on a Minot microtome, after which the sections were counterstained on the slide with a seventy per cent. alcoholic solution of Bismarck brown and mounted in Canada balsam.

Indiana University, Bloomington.

Explanation of Plate XXXIV.—Fig. 1, longitudinal section of young ovule; embryo-sac mother-cell with contents indicated. × 375. Fig. 2, same farther advanced; the outer integument on the right left off. × 375. Fig. 3, cross section of nucellus of a similar stage. × 375. Fig. 4, embryo-sac mother-cell divided by transverse wall. × 560. Fig. 5, embryo-sac mother-cell divided into three cells, the larger, lower one with large nucleus and two distinct nucleoli. × 560. Fig. 6, embryo-sac with two nuclei travelling toward opposite ends. × 560. Fig. 7, these nuclei have doubled and occupy the ends of the sac; a large vacuole occupying the cavity of the sac. × 375. Fig. 8, mature embryo-sac with surrounding cells of nucellus. × 279. Fig. 9, egg-apparatus; endosperm nucleus near it. × 375. Fig. 10, antipodal end, the cells lying free without definite walls. × 560. Fig. 11, two antipodal cells. × 560. Fig. 12, pollen spore of sterile stamen in female flower. × 375. Fig. 13, pollen spores of male flower. × 375.

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[1]Strasburger: Angiospermen und Gymnospermen, Jena, 1879.

Achenial hairs of Compositæ.

MARY A. NICHOLS.

WITH PLATE XXXV.

In the older systems of classification little attention was given to the anatomical structure of plants. It was sufficient to consider only morphological characters. There is, however, a growing tendency to study the minute anatomy and bring it into requisition, as Engler and Prantl have done in many cases in their admirable work "Die natürlichen Pflanzenfamilien."

Many botanists have made comparative studies of different orders, as Leonhard[1] has done for the *Apocynaceæ*, Kuntze[2] on comparative anatomy of *Malvaceæ* and Schumann[3] on the limits of anatomical variation in the same species. American botanists have not been slow to make use of anatomical characters when they could do so. Thus Engelmann[4] long ago called attention to the valuable characters found in the anatomy of the pine leaf. Later Coulter and Rose[5] made a comparative study of our North American pines. They also studied the fruits of *Umbelliferæ*.[6]

In the difficult task of classifying the order *Compositæ* the most minute details of structure are brought into requisition for the determination of species.

In a paper recently prepared on the style-characters of the *Compositæ*, Chamberlain[7] calls attention to the revisions made in the order since the elaboration of the same by Linnæus who divided it into four groups. He notes the fact that Henri Cassini, Lessing, De Candolle, Bentham, and Gray have made use of the style characters in the arrangement of

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[1] LEONHARD, MICHAEL: Beiträge zur Apocynaceen, Bot. Centralblatt. XLV. I, 33, 65, 97, and 129.

[2] KUNTZE, GEORGE: Beiträge zur vergleichenden Anatomie der Malvaceen, Bot. Centralblatt. XLV. 161, 197, 229.

[3] SCHUMANN, PAUL: Beiträge zur Kenntniss der Grenzen der Variation im anatomischen Bau derselben Pflanzenart, Bot. Centralblatt. XLV. 356, 389, and XLVI. I.

[4] ENGELMANN, GEORGE: Trans. St. Louis Academy of Sciences. III. 595, 602.

[5] COULTER, J. M. and ROSE, J. N.: Synopsis of North American Pines, based upon leaf anatomy, Bot. Gazette. XI. 256, 302.

[6] Notes on Umbelliferæ of East U. S. Bot. Gazette. XII. 12, 60, 73, 102, 134, 157, 261, 291.

[7] CHAMBERLAIN, J. S.: Comparative study of the styles of Compositæ, Bull. Torr. Bot. Club, XVIII. 175.

the order, and further states that the pappus is of greater diagnostic value than the achenium. Whether or not the statement with reference to the achenia will stand, remains to be shown. Little attention has been given to a microscopic study of achenia but Macloskie[8] and Loose[9] have both studied the minute structure of the achenia of *Compositæ*.

Gray, in his manual, frequently notes the presence of achenial hairs, but comparatively little microscopic work has been done on the anatomy and physiology of these organs. Hence their value as specific characters remains to be determined.

The hairs on the *Compositæ*, especially those of *Senecionidæ*, are of peculiar interest.

The subject has been discussed by Pammel[10] and references given.

Harz[11] figures achenial hairs on *Taraxacum* and the more or less papillose cells of *Scorzonera*. Loose makes the statement that the anatomical characters of the fruit in a genus are usually alike although exceptions are found in *Anthemis*, *Pyrethrum*, and *Chrysanthemum*. He figures the hairs on *Callistephus Chinensis* and *Zinnia verticillata* in his Fruchtschale der Compositen.

Heineck[12] incidentally refers to the anatomical structure of the hairs on the fruits of *Compositæ*, but he was chiefly interested with reference to their mechanical function.

Macloskie[8] points out similarities of achenial-hair structure in the more closely allied groups and also notes a discrepancy in the group *Cynaroideæ*, which, if this be made a basis of classification, would lead to the division of the group, placing *Carlina* and *Xeranthemum* nearer the *Asteroideæ* while the true thistles, in the absence of hairs, resemble the members of the group *Cichorieæ*. Macloskie has further described and figured the hairs on different genera of other tribes of this order.

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[8] MACLOSKIE, GEO.: Amer. Naturalist, Jan. 1883.

[9] LOOSE, RICHARD: Die Bedeutung der Frucht und Samenschale der Compositen für den ruhenden und keimenden Samen, Inaugural Dissertation, Berlin, 1891.

[10] PAMMEL, L. H.: On the seed-coats of the genus Euphorbia, Trans. St. Louis Acad. of Sciences, v, no. 3. He gives a list of papers bearing on the subject of mucilaginous cell-walls in this paper.

[11] HARZ: Landwirtschaftliche Samen Kunde, II. 843–866. Paul Parey, Berlin, 1885.

[12] HEINECK: Beitrag zur Kenntniss des feineren Baues der Fruchtschale der Compositen. Inaugural Diss. 1890.

In the preparation of this paper, two types of achenial hairs have been observed: 1. a simple, pointed hair having, apparently, no median line or division wall; 2. a compound or double hair, branching so as to form a double-pointed apex. The former will be designated as "simple" and the latter, with all modifications, will be included under "duplex hairs," a term used by Macloskie.

Of the entire list studied, the only simple hairs found were in *Rudbeckia* and *Centaurea*.

Those found to bear duplex hairs are *Eupatorium*, *Aster*, *Coreopsis*, *Dysodia*, *Bigelovia*, *Bidens*, *Kuhnia*, and *Liatris*.

As may be seen, this division does not follow closely the established lines of group division. Aside from the digression already noted by Macloskie in the group *Cynaroideæ* may be mentioned the fact that *Centaurea*, of this same group, has long simple hairs. This puts into one group the three possible divisions which may be made with reference to achenial hairs. In the *Helianthoideæ* also several genera, as *Helianthus*, *Coreopsis*, and *Bidens*, present distinct duplex hairs; on *Lepachys* they are of the simple kind and on *Xanthium* and *Silphium* no hairs are found. Among the *Asteroideæ*, the genera *Aster* and *Bigelovia* have conspicuous duplex hairs while on others, as *Grindelia* and *Erigeron*, no hairs are found.

In other groups similar differences occur which would seem to preclude the possibility, or at least the advisability, of accepting these as tribal characters. Within the genus however, the character seems to be more constant and might, perhaps, be made of value in the determination of species.

In *Eupatorium villosum* Swartz the hairs are comparatively short and have lateral canals which appear also to form or to follow the division wall in those duplex hairs in which this wall is visible. Whether the non-appearance of this wall in some duplex hairs was due to the accidental placing of the hair upon the slide or to the fact that this is an inconstant structural character, the writer was unable to determine.

In *Liatris gracilis* Pursh a number of the hairs when first examined appeared simple, but closer investigation revealed, in nearly every case, a rudimentary growth at the base, establishing the duplex character of the hair. In these hairs cross canals were plainly noticeable, especially after the application of glycerine.

The hairs of *Kuhnia eupatorioides* L. present few structural characters and on the whole, seem imperfect. No canals or division walls appear. Many of the hairs are small and show neither the double tip nor the basal rudiment. If these specimens should prove perfect and this irregularity a fixed character it might materially alter conclusions, but it is probable that further examination will prove the hairs of *Kuhnia* to be duplex and these specimens imperfect.

The asters all have long, distinct, duplex hairs. *Aster macrophyllus* L. has some duplex only at the base and in another case three tips were distinguished. The lateral canals are distinct, but their walls are sometimes broken, affording transverse communications. In *Aster laevis* L. are found the same characters. Although in two thirds of the specimens only one tip is visible, yet the hairs have every other appearance of being duplex. The hairs from *Aster oblongifolius* Nutt. are somewhat thicker and have sharply pointed tips. The tip form, however, varies too much within the species to give it any specific value. In many cases in *Aster Novæ-Angliæ* L. the tips are deeply cleft and of unequal length, but here too the variations are so great as not to offer any specific characters.

Bigelovia nudata DC. presents a slight irregularity of appearance. The canals seem to extend through the center of the hair. This may, however, be due to the position and transparency of the hair, which, combined, give to the division wall the appearance of a canal. This supposition seems more probable since in the cases where only one half of the hair is developed, the canals are in the usual lateral position.

Rudbeckia pinnata Vent. introduces us to the group *Helianthoideæ* and presents a marked contrast to any of the preceding. The hairs are much thicker and less acutely pointed. In one case the canals seem to ramify irregularly. In another case the hair appears to be distinctly jointed, while a third form has the usual structure, lateral canals and transverse connections.

In *Bidens frondosa* L., also of the group *Helianthoideæ*, the hairs seem at first to be simple but close study shows irregularities of structure which would make them of the duplex type, at least in the more mature stages. The fact that some of the younger growths are so distinctly simple might indicate that the two parts do not always develop

simultaneously. These hairs also show unusual differences of length.

Coreopsis aristosa Michx. is very similar to the preceding. The hairs are of various lengths and diameters, have lateral canals, and are probably all duplex when perfectly developed.

Helianthus occidentalis Riddell of the same group, is also very similar, except that the tip is perhaps less deeply cleft. Occasional specimens seem simple except for a line through the center, answering to the median wall.

In *Dysodia papposa* (Vent.) Hitchcock, the hairs are rather more slender, double tipped, but show no division wall.

In *Centaurea Cyanus* L. they are very long, slender, and indistinct. No transverse canals are found, and the apex is sharply pointed.

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BIBLIOGRAPHY.

1. HÆNLEIN, F. H.: Beiträge zur Entwickelungsgeschichte der Compositenblüthe, in Schenk und Luerssen, Mitth. II. 144–179.
Abstr. Warming und Loew, Just Bot. Jahresb. 1874, p. 486.

2. HOCH, FRIEDRICH: Vergleichende Untersuchungen über die Behaarung unserer Labiaten, Scrophularineen und Solaneen. Freiburg, 1885.

3. KRAUS: Ueber den Bau trockener Pericarpien. Pringsheim, Jahrb. f. wiss. Bot. V. 83.

4. KRONFELD, MORITZ: Ueber einige Verbreitungsmittel der Compositenfrüchte. Sep. Abdr. aus Sitzungsb. d. K. Akad. d. Wiss. in Wien, I Abth. 1885. Mai Heft. Abstr. Möbius, Bot. Centralb. XXV. (1886). 37.

5. SCHENK: Zur Kenntniss des Baues der Früchte der Compositen und Labiaten. Bot. Zeit. 1877, no. 26.

6. SCHMIDT, CARL: Vergleichende Untersuchungen über die Behaarung der Labiaten und Boragineen. Inaugural Diss., Rybnik, 1888.

7. TRELEASE, WM.: North American Geraniaceæ. Mem. Bost. Soc. Nat. Hist. IV.

EXPLANATION OF PLATE XXXV.—1. Eupatorium villosum Swartz.—2. Liatris gracilis Pursh.—3. Kuhnia eupatorioides L.—4. Aster macrophyllus L.—5. Aster laevis L.—6. Aster oblongifolius Nutt.—7. Aster Novæ Angliæ L.—8. Bigelovia nudata DC.—9. Rudbeckia pinnata Vent.—10. Bidens frondosa L.—11. Coreopsis aristosa Michx.—12. Helianthus occidentalis Riddell.—13. Dysodia papposa (Vent.) Hitchcock.—14. Centaurea Cyanus L.

The bacterial flora of the Atlantic ocean in the vicinity of Woods Holl, Mass.

A contribution to the morphology and physiology of marine bacteria.

H. L. RUSSELL.

WITH PLATE XXXVI.

In a previous paper[1] was recorded a series of observations upon the bacterial life of the Mediterranean which were made at the Naples Zoological station during the spring and summer of 1891.

This paper contained a number of facts that had been gathered from a study of the bacterial life of that region, but the area covered was too limited to allow any general conclusions to be drawn concerning the bacterial life of the sea. The importance of a more thorough biological knowledge of the micro-organismal life of the marine waters led to a desire to continue this line of research, so the opportunity offered through the kindness of Prof. C. O. Whitman, Director of the Marine Biological laboratory at Woods Holl, Mass., to carry on a similar line of work at that station was eagerly accepted.[2]

The thorough elucidation of the laws that govern the distribution of this class of organic life can only be made upon extensive data gathered not only under similar but widely diverse conditions. A comparative study of the bacterial flora on this side of the Atlantic with that of the Mediterranean was therefore of importance, so the plan of work this season was practically the same as that of the previous year. Frequent reference will of necessity be made to the previous communication and some of the results that will be detailed here will have been considered before to some extent, but as the conclusions then drawn were only provisionally suggested, the confirmation of them will substantially increase their basis for support.

The main object of the work at Naples was a study of the deep sea bacteria and the sea bottom as well as the water was also examined from the shore line down to a depth of 3,500ft.

[1] Zeits. f. Hyg. xi. 165–206.

[2] The quantitative part of the work was done at this station while the more detailed study of the individual forms was carried on at the biological laboratories of the University of Chicago.

A continuation of the study of the deeper waters was precluded at Woods Holl by reason of the shallowness of the ocean in the vicinity of this port. The shallow continental platform which skirts the eastern edge of the U. S. is here at its greatest width and the broad shoals of Nantucket are even out of sight of land. The conditions however were favorable for the investigation of marine forms in general.

Woods Holl is situated at the extremity of a narrow neck of land that pushes southward from the southernmost point of the Cape Cod peninsula. This narrow land strip is continued seaward in the chain of the Elizabeth Islands and divides Buzzard's Bay, an almost land-locked sea, from Vineyard Sound. This latter body of water separates the mainland and the Elizabeth Island chain from an outer range of islands comprising Nantucket, Martha's Vineyard and others.

The soil of the mainland is of a sandy nature and the general aspect of the surrounding country is that of low hills such as usually characterize a glaciated region. As there are no rivers of any magnitude, and no large cities to add their filth to the ordinary land drainage, the factor of land contamination is here reduced to a minimum.

Both the bodies of water mentioned, Buzzard's Bay and Vineyard Sound, served as a collecting ground for this work. Both are subject to tidal changes; the Sound being swept from end to end by an especially heavy tide.

The physical characters of the sea-bottom of these two bodies of water differed considerably, that of the Sound being of a sandy or rocky nature, while the bottom of the Bay, excluding a narrow littoral belt which is more or less sandy is covered with a uniform sheet of blue or gray silt. No depth within a working distance of the laboratory exceeded 65^{ft}, while the 20-fathom line was out of sight of land. Consequently all samples secured were from comparatively shallow depths, although in some cases twenty miles from the main land, with the exception of a few that were taken on board of the U. S. F. C. steamer *Grampus* at a distance of about 100 miles from the coast.

Methods.

The methods used in securing the samples of mud and water to be analyzed were essentially the same as those that were employed at Naples. These methods have been de-

scribed elsewhere, so that a detailed account of them again is unnecessary.[8]

The use of the water apparatus for the second season has confirmed the favorable results obtained during the preceding year. By means of it, a sample of water may be taken from any depth without the slightest contamination from the intervening water masses. The cheapness and ease with which this simple piece of apparatus can be made makes it all the more applicable for its purpose.

The culture technique was substantially the same as used at Naples, so that direct comparisons might be made. Sea water was usually used in the preparation of the agar and gelatine media.

Relation of bacteria to marine waters.

In considering the bacterial content of the sea, attention will first be directed toward the water itself, as a home for bacterial life. When tested by culture methods, the results of the analysis of waters taken at Woods Holl have been of a positive nature, with but two exceptions. Samples were secured under as different conditions as possible, ranging from the surface of the water to the ground layer, and from the shore line to a distance of twenty miles from mainland. The number of germs per unit of volume (1^{cc}) varied within wide limits but to a much less extent than in fresh waters. When extraordinary numbers of bacteria were found in the cultures, one species almost always predominated to a large degree. The possibilities of the introduction of a small bit of floating zoogloea that might happen to be in the water renders this fact easily explainable. If the sample secured contained a fragment of the gelatinous mass of germs, it would be broken up in the preparation of the cultures and the separated germs would develop as isolated colonies and thus raise the normal average.

The following table summarizes the results obtained from the analyses of nearly fifty samples of water that were taken. The figures in the table indicate the average of the whole number of colonies that appeared in all the cultures made from samples at different depths. Those samples that contained enormous numbers and all of one kind were excluded from this set of averages.

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[8] Zeit. f. Hygiene, XI. 166. Botanical Gazette, XVII. 312.

DEPTH OF WATER IN FEET.	NUMBER OF BACTERIA PER CC. FOUND IN THE WATER AT DIFFERENT DEPTHS (IN FEET).									
	0	15	20	25	30	35	40	45	50	65
30	6	8	....	....	46	....	....	....	....	....
35	....	....	....	....	....	175	....	....	....	....
40	....	....	3	....	....	....	105	....	....	....
45	....	....	....	16	...	....	....	5	....	....
50	....	....	....	18	....	....	....	....	40	....
55	....	....	....	....	....	....	....	....	....	....
60	....	....	....	....	....	....	....	....	....	....
65	110	....	....	....	120	....	....	....	...	6

As the above table indicates, the limits of variation per unit of volume varied from a few germs to about 120. No especial difference in numbers can be noted in the various depths that may not be ascribed to local variations. The water seems to be peopled at all depths with bacterial life, and the deeper layers appear to be as rich as the more superficial. These results, on the whole, agree quite closely with those obtained at Naples. Although the depth there was much greater, no marked diminution could be detected between the superficial and the bottom layers. Almost every cubic centimeter of water subjected to analysis contained bacteria, usually not exceeding one hundred germs per unit of volume. Karlinski[4] in studying the waters of Lake Borke, one of the fresh water lakes in Bosnia, arrives at a somewhat different conclusion. He finds that the germ life is much richer at the surface and that there is a gradual diminution in numbers as samples from increasing depth are examined. His investigation, however, only extended to the depth of fifty feet. It is surprising that there should be so marked a decrease in numbers as he gives with such a slight change in depth. This is certainly not the case with marine waters already examined, as the analyses made at Naples and at Woods Holl fail to show any law of distribution in this manner.

Whether the great bulk of the ocean waters is inhabited by micro-organisms is not yet positively known, as no bacteriological examination has been made of water at great distances from land. In fact the knowledge that we possess of

[4] Cent. für Bakt. XII. 220.

this class of life in the open ocean is practically nothing, for scientific expeditions have as yet paid no attention to the investigation of these forms.

While we have no direct knowledge concerning their presence in mid-ocean, it is not unreasonable to suppose that they are present throughout the great mass of oceanic waters. The conditions for their development here are quite as good as are found in fresh water. True it is that many forms in fresh water are of undoubted land origin, but we recognize numbers of species as being so well adapted for development in water alone, that they have received the name of "water bacteria." As we look upon the sea as the original home of organic existence, it is not at all improbable that these primitive generalized types of life may have been dwellers in the deep from time immemorial.

Although positive proof concerning the universality of bacterial distribution in the ocean is yet wanting, we have the strongest circumstantial evidence and that is the presence of identically the same species on this side of the Atlantic that have been found in European waters. This point will, however, be considered later in another connection.

The gradual disappearance of bacterial life in fresh water lakes as the distance from the shore increases has led some to think that bacteria are present in sea water in only limited numbers. They regard the presence of micro-organisms as evidence of land contamination and where this disturbing factor is excluded, the normal number of bacteria is regarded as extremely small. That there is a marked diminution in germ life as we recede from the shore is undisputed, but this decrease soon reaches its minimal point and then the proportion remains fairly constant. Even where the condition for introduction of land-derived forms is as favorable as it is in the harbor of a large seaport, the point of minimal diminution is usually reached within a distance of three or four miles from land. With the ordinary coastal drainage the influx of fresh water forms does not affect the average content to as great a distance as this.

A comparison of germ life of salt with that of fresh water shows that the latter is usually much richer in bacteria. The principal reason for this is perhaps the closer proximity of fresh water to the soil layer, the upper strata of which are so rich in bacterial life. Every rain fall brings innumerable

germs to the water level and thus raises the average greatly for the time being at least. Then another cause is the greater rapidity of multiplication in these waters on account of the higher temperature.

Comparisons can scarcely be made under equal conditions between the bacteria found in streams and springs and those inhabiting the ocean. The proportions existing between the waters of our great inland seas and that of the ocean would be much more reliable but as we have no data concerning the bacterial contents of these large fresh water masses, this can not at present be made.

In the light of our present knowledge, the assertion seems to be warranted that marine waters are not as rich in bacterial life as fresh water masses.

The question of the vertical distribution of bacterial life throughout large bodies of water has a direct relation to the problem of sedimentation. The specific gravity of bacteria cannot exceed very much that of water, especially saline solutions like the sea, yet it would not be unreasonable to suppose that these organisms would slowly tend to settle to the bottom in obedience to a universal law. Especially would this be likely with forms that are in a spore condition, as they are immotile and of higher specific gravity than active protoplasm.

But the question as to whether there is a "perpetual shower" of germ life on the sea bottom is not so easily answered. A number of opposing factors enter into the question and make it difficult to say what actually takes place under natural conditions. The experiments of Bolton, and Hüppe upon the settling of bacteria in tall cylinders do not give any positive answer, for the natural increase by growth is counterbalanced by the constant dying off of old forms.

Motility is another factor of the problem as those germs endowed with locomotor powers are easily able to overcome the effect of gravity.

Cramer[5] who has investigated both the superficial and deep waters of Lake Zurich is unable to note any marked difference in numbers between the surface and the ground layer.

This season's work substantiates the results of the previous year and leads us to the conclusion that the deeper layers are as rich in bacterial life as the surface. Whether this is true

[5]Die Wasserversorgung von Zürich. 1885.

for the abysmal depths of the ocean is hazardous to say. The diminution in temperature as the depth of the ocean increases will of course retard the growth of micro-organisms. The deepest point from which water samples were taken in the Mediterranean (3,200 ft.) showed thirty germs per cc. but the temperature in this instance was high for deep water as this sea has a constant temperature of about 55° F. below the 600 feet line.

Relation of bacteria to the sea-floor.

When we consider the bacterial flora of the sea-bottom, the results of the analyses of mud show a widely different condition. Micro-organisms are always present in very great numbers. Numerically, as regards the bacterial contents, the sea floor bears a similar relation to the superincumbent water masses that the superficial soil layers do to the atmosphere above. This is only true, however, from a numerical standpoint, for the water does not derive its bacterial life from the sea floor, while the germs in the air have their origin in the soil. In only two instances have I found at Woods Holl forms in the water that plainly showed that they were derived from the slime layers below. These cases are explainable, however, for a heavy tide was noted at the time the samples were taken and it is highly probable that the tidal current detached particles of mud from the bottom and thus the mud bacteria were included in the sample of ground water, although five or six feet from the bottom.

The analyses of the sea bottom that were made at Woods Holl this season covered nearly one hundred tests. Most of the samples were secured from Buzzard's Bay and Vineyard Sound and included material of widely varying physical characters. The area covered was not far from one hundred square miles and included all depths from the shore line to sixty-five feet.

In the ninety-five samples that were analysed from this locality, the average number of bacteria per cc. was about 17,000. In no case was a sample of mud tested by means of culture methods that did not yield bacteria although the limits of variation were wide.

In a few instances, the number of germs present were fully 100,000 per cc., but these exceptional cases are to be ex-

plained in the same way as in those samples of water that far exceeded the general average.

Not much of an idea can be gained from an average like this unless other conditions are taken into consideration.

As there was a wide difference between the physical character of the sea bottom at the various places from which samples were taken, the analyses have been arranged with reference to this point to see what effect the substratum had upon the presence of bacterial life.

The opportunity for a comparison of this nature was all the more favorable at Woods Holl on account of the slight variation in the depth of the water. All samples that were analyzed were secured at depths ranging from 25 to 65^{ft}, so that this factor was fairly constant. According to the analyses made at Naples, this element of depth entered very strongly into the problem of quantitative distribution, there being a marked decrease in numbers as the depth increased.

It has already been ascertained through the investigations of Fränkel[6] and Reimers[7] that virgin soil is much poorer in bacterial life than that which has been disturbed, and that in a general way, the bacterial contents of a soil are largely dependent upon the amount of organic material that is contained therein. As the sea bottom is practically undisturbed as far as the influence of man is concerned, a comparison of the germ life of different soil bottoms ought to yield natural results.

From a mechanical standpoint, a fine silt would offer better conditions for bacterial life than a coarser soil, as there is more room in the interspaces in which the bacteria may develop.

Whitney[8] has estimated the absolute empty space in sand to be 45 per cent. of its volume while that of clay is fully 25 per cent. more.

The majority of the samples that were taken from the sea bottom were either composed of a very fine silt or a fine quartz sand mixed with clay. In several instances, samples of pure "live" sand, as these shifting shoals are called, were also tested as to their bacterial life. Grouping the analyses according to the physical character of the bottom from which the respective samples were derived, it was found that thirty

[6] Fränkel: Zeits. f. Hygiene II (1887). 521.
[7] Reimers: Zeits. f. Hyg. VII (1889). 307.
[8] Whitney: Fourth Md. Agric. Rept. (1892). 281.

tests of the very fine blue and gray silt yielded on the average about 17,000 germs per cc. Thirty-five samples of a mixed quartz sand and clay gave an average of nearly 20,000 germs per unit of measure. The few samples of pure shifting sand were practically free from organic matter and contained only about 5,000 germs. Not enough tests were made to say whether this ratio would be maintained or not, but the difference between the sandy clay and silt is quite within the limits of ordinary variation. The species found in the pure sand did not differ from those growing in the clay soils.

Quantitatively, the marine mud in the vicinity of Woods Holl contains much less germ life than that of the Mediterranean in the vicinity of Naples. The Naples cultures made from mud taken at the depth of 150" or less, yielded usually from 200–300,000 germs per cc., while those made on this side of the Atlantic in only exceptional instances exceeded 50,000 germs while the average content was about 15–20,000 per unit of volume. Just what conditions bring about such a marked diminution is not easy to see. The figures given for the Naples analyses include only the samples taken at a distance of two miles or more from land. From the appearence of the cultures, this limit seemed to be outside of the influence of land contamination. The majority of sewage and fresh water forms do not find favorable conditions in the sea for their development, but it is highly improbable that all germs introduced in this way are destroyed. Many no doubt adapt themselves to their changed conditions and are able to live. At all events, the conditions at Woods Holl are in all probability more nearly normal than they are at Naples, as the possibility of the introduction of such enormous numbers as would be derived from a large city are in this case excluded.

This season's work has been carried on in much more northern waters but the difference in temperature is not great. The period of observation at Naples extended from April to July, the temperature of the water during this time varying from 60°–75° F. This year the work was carried on somewhat later (June–August), the temperature ranging from 55°-70° F.

Temperature is one of the more important factors that govern the distribution of micro-organisms, but it would seem in this case that the difference in bacterial contents of the

two localities examined must be explained in some other way.

As yet, we do not possess sufficient knowledge concerning the distribution of bacterial life to satisfactorily explain this peculiarity.

Relation of the bacteria of the sea bottom to the superposed water masses.

The idea was advanced as a result of last year's tests that the high content of mud when compared with water was in part due to the growth of distinct species that were to be found *only* in the mud. This indigenous flora was in no way derived from the water masses above but had spread itself over the sea bottom in a way not at present thoroughly understood. This theory was based upon the fact as determined by cultures that at least 35 per cent. of the total bacterial contents of the Mediterranean mud in the vicinity of Naples was included in three species that were exclusively slime bacteria.

The work this season afforded an opportunity to test the correctness of this view on data from a widely different source.

The idea has already gained some ground that the soil bottoms of the oceans have derived their bacterial contents from the water mainly as a result of sedimentation.

This result is based upon the fact that while river water is usually rich in germ life, lake water is poor; therefore it is inevitable that the mud must have derived its bacterial life from the lake water by sedimentation.

Practically no data had ever been gathered on the richness of either lake or sea bottoms in bacterial life from a quantitative standpoint so that the conclusion was mainly an *a priori* one. The results of experimental sedimentation tests do not show that bacteria have any decided tendency toward deposition. The self-purification of polluted streams that used to be explained upon the theory of sedimentation is now accounted for largely in another way and we have no positive experimental knowledge that sedimentation of all these microscopic vegetative forms exists. The results of this season's observations are entirely in conformity with those of the previous year, and indicate beyond a doubt that a large proportion of the bacteria in the mud are inhabitants solely of this habitat.

The majority of the individual germs present are embraced

in a few species. One form, Bacillus limicola, is very common and is almost always found in every culture that is made from the mud. Besides this predominating form there are several other species that are also exclusive mud dwellers. This indigenous mud flora, however, does not make up the entire percentage. In every sample analyzed there is to be found a goodly number of germs that are also inhabitants of the superincumbent water masses. These have not fallen to the sea bottom in a dormant condition, but are actively vegetating, as will be shown in the succeeding paragraph.

The actual stage of development in which marine bacteria are found.

The quantitative analysis of the ocean waters and the underlying floor by means of cultures gives us an approximate idea as to the number of individuals that are to be found therein, but these results do not in themselves tell us the actual condition of the bacteria—whether the germ life is in an actively vegetating condition, or is merely in a quiescent spore stage.

Are the waters of the globe filled throughout with bacterial life in full activity? Is the ocean bottom peopled with forms that are undergoing their cycles of development, or is it merely the resting place for the "perpetual shower" of organic beings from above whose active existence is at an end?

We have determined the presence on the sea bottom of indigenous species, so the most natural inference is that these forms limited to the mud layers must possess the means of carrying on their metabolic activity.

The question can be approached in two ways. One of which is by inferential reasoning and can only be relied upon to the extent of affording a check upon the other method. This is to determine the number of colonies day by day as they appear in the cultures. If the bacteria present are in both a vegetative and spore stage, the time of incubation before the different germs develop into colonies microscopically visible will be quite different. Those germs that are already in an active vegetative condition will immediately begin their growth and with most saprophytic species this will be manifested within thirty-six hours from the preparation of cultures. With those forms that are in a resting stage, the period of incubation will be considerably lengthened. Taking advantage of this fact, we can by counting the number of developing

colonies in the cultures on successive days get an approximate idea as to the actual condition of the bacteria in the sample when it was taken. This method is of course only applicable under certain conditions, for if there is a great variety in the number of different species, the rate of development of the various forms may vary to such an extent as to impair the accuracy of this method.

The method, however, possesses a certain value in the case in hand as the number of species is not large and as it affords a check on the second method which is experimental.

The other method consists in destroying all forms that are in a vegetative state by sterilization at a low temperature. This temperature should not be high enough to injure the germs that are already in a dormant state but should be sufficient to kill all forms having protoplasm in an active condition. The quantitative determination of the bacteria in equal volumes of the sample of water or diluted mud before and after this sterilizing process affords us data for this problem.

Unequal distribution of the germs in the different cultures will materially affect this result, but if proper precautions are taken to thoroughly distribute the bacteria in the fluid before the control cultures are made, this element of error is materially reduced.

Samples of water as well as of mud were subjected to this method of differentiation and were sterilized for one hour at the temperature of 70° C. This temperature is considerably higher than any known form of active protoplasm can endure,[9] so that one may be absolutely sure that all colonies developing in heated cultures originated from sporiferous germs.

Ten series of tests were made with samples taken from the water at varying depths and in all but one of these the "heated" cultures developed bacteria in greater or less numbers. The percentage of sporiferous bacteria in the water varied widely and in two instances the cultures subjected to this partial sterilization showed nearly as many colonies as those untreated. Bacteria, in a spore condition were demonstrated in the superficial water layers as well as at the bottom and intervening depths.

Ten series of tests were also made upon the mud from the sea bottom. These likewise showed a varying percentage of the bacteria present on the sea floor to be in a resting condi-

[9]Except two or three thermophilous species, according to Miquel and Globig.

tion. As in the case with the water cultures the limits of variation with the mud bacteria varied widely. In one instance only (forty-five feet deep) were no bacteria found in spore condition.

These results accord in a general way with those made in the Mediterranean and show that while the water and underlying sea floor are filled with bacterial life, they are by no means in an entirely quiescent condition. Both water and mud are peopled with micro-organisms that are undergoing their cycle of development here as elsewhere.

(*To be continued.*)

University of Wisconsin.

BRIEFER ARTICLES.

Vacation collecting.—I have spent the month of August at Sakonnet Point, Little Compton, R. I. For one week I had the company of Mr. James L. Bennett, who I found had made an extended list of the plants of the region. Among the interesting species are Senebiera Coronopus in great abundance; Woodwardia angustifolia, quite plentiful but not in fruit; and all the queer abnormal varieties conceivable of Onoclea sensibilis.

There is a swamp wood near the house where I am stopping, full of Ilex opaca of large size. I. glabra, I. laevigata, and I. verticillata, also occur. There is a perfect tangle of Mikania scandens, growing high up into the trees. It is rich botanizing all through this swamp. Nowhere did I ever see more brilliant Lobelia cardinalis. We find over forty trees about here, the oak being especially well represented. On all the meadow lands near the sea one finds quantities of Anagallis arvensis. The splendid Hibiscus Moscheutos grows in the salt marshes. I have found no Sabbatias. As curious strays have been picked up now and then in the neighboring town of Tiverton, I am on the lookout for them here. I might say that Physostegia Virginiana is quite common on the roadsides.

In the middle of the swamp wood before mentioned, near a lovely brook, I found a boulder thus inscribed: "To the Memory of Awerstronks, Queen of the Sakonnates, and Friend of the Whiteman." I have spent many happy hours in this secluded spot.

In the early summer I botanized extensively about Mt. Wachusett in company with Mr. J. F. Collins. Afterwards I explored the Taconics with the Harrison brothers, of Lebanon Springs.—W. WHITMAN BAILEY, *Providence, R. I.*

Inter-twining of tendrils.[1]—That the tendrils of certain Passifloræ respond to the contact of one another, and as a consequence form inter-twining coils, was shown in a previous article in this volume, p. 123. In an extension of this work, some attention has been paid to the tendrils of *Micrampelis echinata* (Muhl.) Raf. (Echinocystis lobata.) Chas. Darwin says in regard to this plant:[2] "One of my plants bore two shoots near together, and the tendrils were repeatedly drawn across one another, but it is a singular fact that they did not once catch one another. It would appear as if they had become habituated to contact of this kind, for the pressure thus caused must have been much greater than that caused by a loop of thread weighing only one sixteenth of a grain." He adds, "I have, however, seen several tendrils of Bryonia dioica interlocked, but they subsequently released one another."

The tenor of the paragraph is such that the reader is left to infer that these organs possess such development of the contact sense as to be able to distinguish the contact of tendrils from that of other bodies. This inference is re-asserted in more positive form in many important physiological text books, and the writer would hesitate to offer evidence to the contrary, were not the facts so easily and readily apparent.

It is of interest to know that the plants of Micrampelis echinata, upon which Darwin's observations were made, were raised from seeds sent him by Asa Gray, and the erratic behavior of the tendrils of this representative of an American genus may be due to a changed environment, and climatic conditions. Several plants of this species, growing in a natural situation on the university campus, have been under observation for some time, and all exhibit numerous instances of the inter-sensitiveness of the tendrils. If an active tendril is lightly touched on the sensitive portion of the ventral surface by any part of another tendril, it will form curves in thirty to seventy seconds, while on any one plant can be seen all stages of inter-reaction; tendrils can be found that have recently made contact and formed curves of perhaps forty degrees, others that have formed one or two coils around the grasped portion, and others that have completed the coils and thrown their own free portion into spirals after the manner of mature tendrils. If the tendrils have come in contact at the sensitive part of both, the reactions in each will be similar. The size and elastic firmness of the spirals show that they are functionally normal.

Less frequent examples of inter-twining have also been noticed in

[1]Read before the Botanical Club, A. A. A. S., Madison meeting.
[2]Climbing Plants, p. 131.

the tendrils of *Parthenocissus quinquefolia* (Linn.) Planch. (Ampelopsis quinquefolia Michx.)

From the results of investigation by Haberlandt, Pfeffer, Hofmeister, MacFarlane and others, on various plants showing "contact movements," it appears that none have developed the contact sense in such a manner as to be able to distinguish portions of its own or similar plant bodies from foreign objects, as would be implied in the results of Darwin's observations. Some of the workers named, however, have quoted this statement of Darwin's, but apparently without having confirmed it by actual experiment or observation.

In general it may be safely said that tendrils distinguish only the force of the impact, and roughness of the surface of a body coming in contact with them, and the assertion is hazarded that the inter-reaction of tendrils will be found present in all tendril plants having a habit of dense, vigorous growth.—D. T. MacDougal, *Botanical Laboratories, University of Minnesota.*

CURRENT LITERATURE.

The power of bacteria to penetrate vegetable tissue.

An admirable and much needed piece of work has been done by Dr. H. L. Russell,[1] now of the University of Wisconsin, in adding to and setting in order the scattered knowledge regarding the power possessed by bacteria to penetrate and induce pathological changes in healthy vegetable tissues. He finds from his own researches, what has already been held as highly probable by many vegetable pathologists, that "normally, the healthy plant with intact outer membranes is free from bacteria within its tissues." But this is not due apparently to any marked germicidal properties of plant juices, and in this respect there is a great difference between plants and animals. Many species of bacteria, including animal parasites, plant parasites upon other hosts than those in which they are parasitic, and saprophytes, more especially the last, are able to live for some time, when artificially inoculated, and even to spread through the tissues to a limited extent. In such cases no evident pathological changes are brought about, and the intruding germs eventually disappear.

The method by which germs effect their distribution, which is almost invariably from one cell cavity to another, and not intercellular,

[1] Russell, H. L.: Bacteria in their relation to vegetable tissue; a dissertation presented to the board of university studies of the Johns Hopkins University for the degree of doctor of philosophy. 41 pp. Roy. 8vo. Baltimore, 1892.

was not definitely ascertained; it does not, however, appear to be dependent upon the currents of water in the plant, but is much more closely correlated with the actual growth of the germs.

Only truly parasitic bacteria appear to have power to penetrate the uninjured surface of plants, and not all of this class.

The author does good service by clearly distinguishing between the *resistance* which plants in general exercise toward the inroads of bacteria, and the *immunity* which certain groups of plants are able to maintain toward bacteria that are pathogenic in closely related sorts. The ability of plants to resist the attacks of bacteria is due to both physical and chemical causes. Of the former are "the epidermal and cortical resistant tissues, matured and thickened cell walls of the inner tissue, exclusion by gummy exudates, etc.," and of the latter "the chemical reaction of the juices, the unfavorable conditions of nutrition, the action of the living protoplasm, etc." "The whole question of immunity of plants from bacteria is much more closely related to the same question as regards fungi than it is to the subject of immunity as seen in the animal kingdom."

In an appendix the author has tabulated the prominent facts regarding the several diseases of plants (1) that are with much certainty established as bacterial (thirteen in number) and also (2) of those ascribed to bacteria but the causal relation still uncertain (nine in number). It is interesting to compare this list with that given by Dr. Migula[2] recently. The latter author admits but five into his list of clearly demonstrated bacterial diseases: pear blight, sorghum blight, corn blight (Burrill), rot of hyacinth (Heinz), wet rot of potato (Kramer). Of the remaining eight of Russell's first list, three are European and excluded by Migula, and five are American and evidently unknown to him.

Most of the work in the study of bacterial diseases of plants has been done by Americans, and it is gratifying to have another important paper added upon the subject, also by an American.

Minor Notices.

A SUMMARY of the species of true yeasts, the spore-bearing Saccharomyces, twenty-two in number, is given in the August issue of the *American Naturalist*, by J. Christian Bay.

A LECTURE upon combating the fungous diseases of plants, delivered before the Massachusetts Horticultural Society by Mr. B. T. Galloway, Chief of the U. S. Division of Vegetable Pathology, has recently been distributed. It is an instructive presentation of the subject.

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[2] **MIGULA: Kritische Uebersicht derjenigen Pflanzenkrankheiten, welche angeblich durch Bakterien verursacht werden. Semarang, 1892.**

OPEN LETTERS.

An American Year-book of Botany.[1]

In the July number of the GAZETTE Mr. J. Christian Bay has given an outline of a proposed bibliography of American botany. Owing to the extreme importance of any measure likely to facilitate bibliographic research, I have ventured to make a few comments on the work contemplated. Mr. Bay alludes to the value of Just's Botanischer Jahresbericht and to its supposed neglect of American botanical literature. Now I contend that the neglect is not on the part of the editors of the Jahresbericht but on the part of the American botanists themselves in failing to send copies of their papers to Prof. E. Kœhne, the editor-in-chief. In the preface of vol. 18 for 1890, published in the last heft just received a few days ago, Prof. Kœhne notes some facts which may account for the little attention paid to American literature. In spite of the urgent request published in the preface of the previous volume and elsewhere calling on botanists and societies to send their publications, only the following journals and reports for 1890 were received from America:—An incomplete set of Bull. Torrey Bot. Club; Report Kansas State Agric. College; Journal of Mycology; Proceedings Interstate Convention of Cattlemen at Fort Worth, Texas; Transactions Kans. Acad. Sci.; Contributions from U. S. Nat. Herb.; Report Section Veg. Path., and Scientific Results of Explorations by the U. S. Fish Commission Steamer Albatross! That is to say, only an incomplete set of one private journal, the other six being published by the government. Of American botanists only the following sent papers: J. M. Coulter, F. V. Coville, Th. Holm, F. H. Knowlton, J. N. Rose, W. T. Swingle, S. Watson, and Geo. Vasey. That is, four from Washington, D. C., and four from other parts of the Union!

For 1889 only *three* journals or reports were sent—all published by the government,—and only *six* Americans sent papers! Is it any wonder that we all know "how little attention it pays to American literature!" Yet the facts indicated above do not show the worst phase of the matter. In Europe, thanks to the enterprise of R. Friedländer & Sohn in publishing *Naturæ Novitates* and to similar bulletins issued by booksellers in other countries, we are able to purchase at very reasonable cost any foreign book or paper almost as soon as issued. This is unfortunately not the case for America. Foreigners have the greatest difficulty in obtaining our works or even in learning what is issued. Cases are not rare where American botanists have purchased abroad the works of their own countrymen that by some fortunate chance had been placed on the market. This state of affairs makes it a hundred fold more difficult to obtain American publications abroad than it is for us to purchase the works of Europeans. If other countries should follow our example and start national year-books in their own tongue, in the end the very object aimed at would be defeated and greater confusion than ever would result. It might possibly be advantageous if a year-book giving a full account of the progress of botany in France were issued, but suppose Italy, Holland, Sweden, Hungary, Russia and

[1]**Though unavoidably much delayed in publication we deem the subject of this letter of such importance as to justify its appearance at this late day.—EDS.**

Japan should follow suit! Yet every one of these countries publishes nearly as much, and several of them more, first class botanical work than is produced in America. How much good would it do American or German or French botanists to have an elaborate year-book in Russian, Polish, Hungarian or Japanese?

To Americans such a bibliography as that proposed by Mr. Bay would be of little value since they are generally well acquainted with the literature as it issues. To foreigners it would simply call for an extra expense to obtain in an unfamiliar tongue what they have a right to expect to find in Botanisches Centralblatt or Bot. Jahresbericht. If the year-book is to reach the widest circle of readers abroad; it should by all means be issued in German or French, or be translated as soon as possible after publication as are Famintzin's *Uebersichten über die Leistungen auf dem Gebiete der Botanik in Russland.*

It is very doubtful whether a publisher could be obtained for such a year-report in German or French unless the author would assume the financial responsibility.

If the work is to obtain the greatest confidence it should be conducted under the auspices of some society or association of recognized standing. Famintzin's reports mentioned above are published by order of the Academy of Sciences of St. Petersburg, the highest scientific body in Russia.

It seems very clear to me that the energy required to carry out the project outlined by Mr. Bay might be spent in some more profitable manner. For instance, prompt and full reviews of American papers might be sent to Botanisches Centralblatt, and authors wishing their papers noticed in Botanischer Jahresbericht could send copies of them to Prof. Kœhne. Of course some persons might feel aggrieved that their second or third rate paper did not receive a highly complimentary two-page notice and might long for a more sympathetic review organ of our own, yet such reasons are hardly sufficient to warrant the outlay of time and money proposed.

It should be remembered that outside of Germany purely bibliographic journals and reports have almost uniformly failed after a few years of precarious existence.

If then French and Italian botanists and American zoologists are able to do without such a year-book it seems quite probable that our own need of such a work is more fancied than real.—W. T. SWINGLE, *U. S. Department of Agriculture, Subtropical Laboratory, Eustis, Florida.*

NOTES AND NEWS.

PROF. J. E. HUMPHREY, formerly of the Agricultural Experiment Station of Massachusetts, intends to spend the coming year in Strasburger's laboratory at Bonn.

IN THE January number of the current volume of the *Forstlich-naturwissenschaftliche Zeitschrift* Dr. F. Ludwig describes a new slime flux caused by one of the discomycetes which he says is identical with *Ascobolus Costantini* Roll.—L. S. C.

The life and works of Dr. George Vasey are treated in an appreciative article by Dr. Wm. Frear in the June number of *Agricultural Science*, accompanied by a portrait.

Mr. Rodney H. True, lately Fellow in Botany at the University of Wisconsin, has sailed for Germany, where he intends devoting especial attention to vegetable physiology under Pfeffer and others.

A striking illustration of the value of pure culture methods in the study of fungi is furnished by results obtained by Dr. H. Klebahn of Bremen.[1] In an investigation of the pine rust he was enabled to identify six distinct species, all of which had been referred by most authors preceding him to a single species, *Peridermium Pini* (Willd.) Kleb.—L. S. C.

Mature perithecia of the European grape mildew, *Oidium Tuckeri*, were found in France last November, by G. Conderc (*Compt. rend.* CXVI. 1893, 210), and prove the long suspected identity of the European and American forms. DeBary expressed the opinion in 1875 that the European oidium was the conidial state of the American *Uncinula spiralis*, but it has not been possible before to establish the fact.

That sundews can capture butterflies seems almost incredible, but Prof. J. W. H. Trail in the July *Annals of Scottish Natural History*, records observing upwards of a dozen of the small heath butterfly, Caenonympha Pamphilus, some dead and others struggling violently, which had been caught by the little Drosera Anglica, near Aberdeen, Scotland. These were all seen at one time within an area of a few square rods, although a few single instances had been previously observed.

A new series of *fungi exsiccati* is announced by J. B. Ellis and B. M. Everhart to be entitled *Fungi Columbiani*, the first century to be ready by the end of the year. It will include only fungi that have already appeared in the issues of the North American Fungi, and is thus a kind of second edition of that work, but does not embrace all the numbers. The first work has now reached the twenty-ninth century, but many of the earlier volumes are exhausted. The proposed series will be distributed in loose packets, and sold at a somewhat lower price than the other.

A Correction.—In the Gazette for September, in speaking of the botanical exhibit made by the agricultural colleges and experiment stations at the Chicago Exposition, it was stated that the part showing diseases of garden crops and fruits was prepared by Prof. Tracy. A note from Prof. Tracy requests us to say that this section of the exhibit was not prepared by him, but that the sheets showing diseases of garden crops were from Profs. Chester and Jones, while those showing miscellaneous diseases of fruits were from Profs. Alwood and Humphrey, and the fine collection of Gymnosporangia was sent by Prof. Thaxter.

The membership of the Society for the Promotion of Agricultural Science was increased at the Madison meeting by the election of twenty-one additional members, including the following botanists: H. L. Bolley, Fargo, N. D.; E. F. Smith, Washington, D. C.; F. D.

[1] Kulturversuche mit heteröcischen Uredineen. Forstl.-naturw. Zeits. II. 69.

Chester, Newark, Del.; L. R. Jones, Burlington, Vt.; L. H. Pammel, Ames, Iowa, and S. A. Beach, Geneva, N. Y. The membership of the society is carefully restricted, numbering forty-two for the last year, with a limit of fifty. The limit is now extended to 100. The increase in the society naturally follows the increased interest in agricultural science, and promises to add greatly to the society's usefulness.

Dr. Robert Hartig[1] has recently investigated the splitting of olive trees, in Italian orchards. He concludes that the so-called splitting is due to the decay of the tissues occasioned by the attacks of *Polyporus fulvus* Scop. var. *Oleæ* Scop. The spores of this fungus gain access to the inner tissues of the tree through wounds; there they germinate, sending hyphæ in all directions, especially up and down the stem and toward its center by way of the medullary rays. A white rot rapidly follows in the path of the fungus. In many cases wounds occur on approximately opposite points on the stem. Where infection takes place in both of these the decay and falling away of the tissues progresses from both to the center, resulting eventually in the formation of an irregular opening through the trunk with sound wood on either side of it.—L. S. C.

The last number of the *Journal of Mycology* is unusually heavy, containing one hundred and fifty pages and fourteeen plates. The articles are substantial and contain much valuable data. The articles embracing experimental data are upon wheat rust by B. T. Galloway, peach rosette by E. F. Smith, Cercospora disease of almonds by N. B. Pierce, leaf diseases of nursery stock by D. G. Fairchild, removal of lichens from tree trunks by M. B. Waite, of which the last is especially noteworthy as a new application of the useful Bordeaux mixture. Descriptions of new species of fungi are recorded by J. B. Ellis and S. M. Tracy, and reprint of descriptions from the Connecticut Station reports with additional remarks by Roland Thaxter. Notes on fossil fungi by Jos. F. James, notices of recent literature, and 349 additional entries in the index to literature complete the contents.

The society for the Promotion of Agricultural Science held a successful meeting in Madison, August 15th and 16th. Not as many botanical papers were presented as usual, although more than half the members present were botanists. Prof. C. E. Bessey gave an account of the distribution and abundance of the various species of weeds of Nebraska. Prof. Geo. F. Atkinson described and exhibited illustrations of a new disease (œdema) of apple, forming blisters upon the bark of the younger shoots. Prof. J. C. Arthur spoke of an important law affecting improvement of crops, by which any increase in cultivation, food supply, or other means of accelerating growth, except use of larger seed, increases the vegetative part of the plant more in proportion than the reproductive. A paper was read (in the absence of the author) from W. G. Farlow, upon the occurrence of white huckleberries, mentioning the previously known occurrence of albino forms, and describing his successful search for the white and spotted forms which have been known in Europe but never before recorded from America. He also determined that the change of color in the latter is due to a fungus, probably the same as the European one.

[1] Die Spaltung der Oelbäume. Forstl naturw. Zeits. II. 57.


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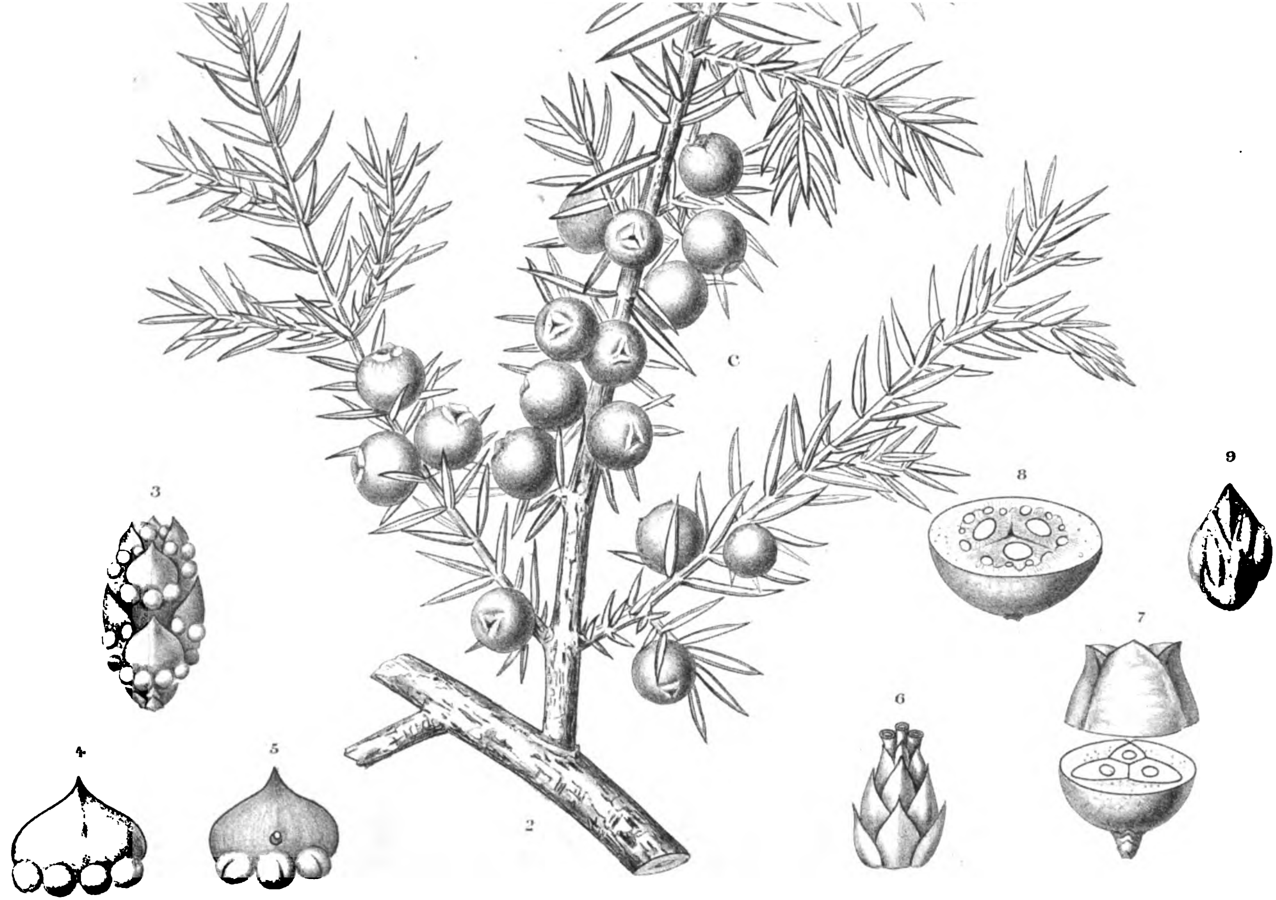

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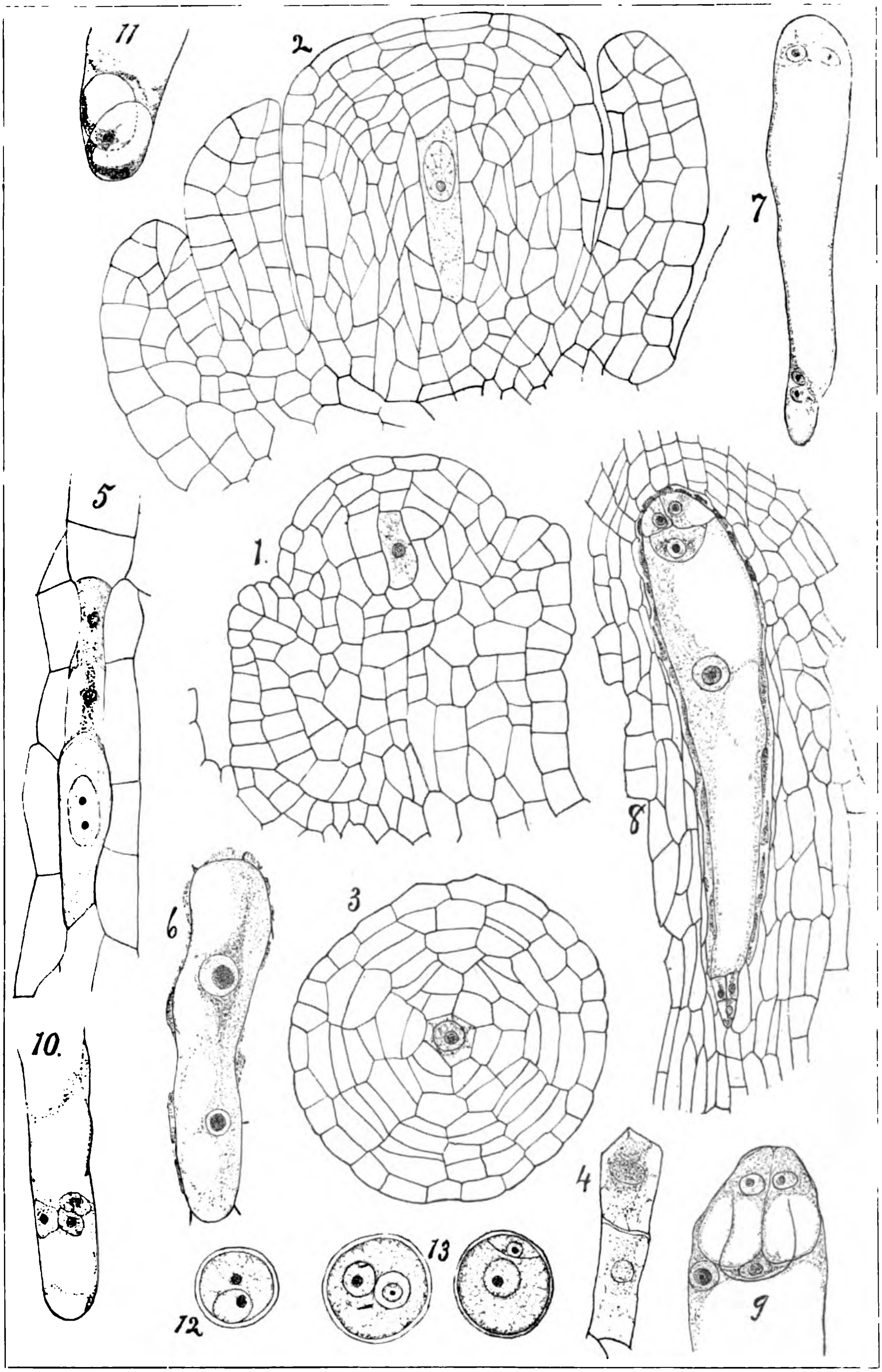

MOTTIER on ACER.

NICHOLS on ACHENIAL HAIRS.

BOTANICAL GAZETTE

NOVEMBER, 1893.

On the food of green plants.[1]

CHARLES R. BARNES.

The constant tendency of biological science is to minimize the difference between the physiological processes of plants and animals, and to recognize, under the varying forms, a remarkable functional unity. External form and even function were studied long before it was known upon what, in essence, both depended. Dujardin, a zoologist, seeking in 1835 a name for the living matter of which some of the simplest animals were composed, selected the word "sarcode." Von Mohl, a botanist, seeing in 1846, in the cells of some plants, previously unnamed contents which he considered the simplest living material, called it "protoplasm." The acute Payen immediately suspected the identity of these two substances. Cohn in 1850 maintained this identity. But it was not till 1860 that Max Schultz definitely established it. This year 1860 marks an epoch, since modern biology takes thence its rise, thanks to Darwin and Schultz.

Having thus a common starting point in its physical basis, it was natural to expect that the manifestation of life in plants and animals should be essentially similar. Unfortunately, not only in the popular mind are the functions of plants and animals supposed to be radically unlike, but even in many scientific or pseudo-scientific text books they are either specifically or impliedly treated as belonging to totally different categories. And the popular notion is in reality derived chiefly from the text books; although the newspaper article is responsible for much "science falsely so called." This notion apparently depends in part upon the superficial, yet apparently radical, differences between the higher plants and the higher animals; and is deepened by the fact that we are con-

[1]**Read before section G, A. A. A. S., Madison meeting, August, 1893.**

scious animals and, looking at the plant from our point of view, assume an *a priori* difference.

Since the time of Linnaeus' dictum concerning the three kingdoms—"Minerals grow; plants grow and feed; animals grow, feed, and move"—text book writers, some even of the highest rank, have attempted to define the differences between plants and animals. These alleged differences have been growing fewer and fewer, and it is the purpose of this paper to show that another difference is only superficial, and so to demonstrate more completely the unity in diversity that exists in the physiology of living things.

Among the supposed differences between green plants and animals, none has been more persistently urged than this: Green plants live chiefly upon inorganic food, obtained in the form of CO_2, H_2O, and mineral salts; whereas animals require organic food. This statement is so trite that it is not necessary to cite any specific illustrations in evidence. It is conceded that the nutrition of fungi is essentially animal-like in the character of the food. These organisms require organic substances which have come into solution through physical or chemical causes independent of the fungus, or those which have been dissolved by chemical substances (generally enzymes) secreted by the fungus filaments. In passing it may be remarked that we have in the latter cases a process entirely like digestion in the animal stomach or in the food vacuole. In fact the term digestion, meaning the alteration of foods and their solution preparatory to absorption, is strictly applicable to this process, and ought to be applied to it.

In regard to the food of green plants, it must first be noticed that in a scientific sense the terms organic or inorganic are now obsolete, or at least obsolescent among chemists, just as the terms invertebrate and cryptogam have become obsolete in classification among biologists. The latter words are still popularly used because they conveniently indicate, in a very general way, a vast number of beings, which however have little in common except negative characters. Organic substances are popularly defined as those produced by the action of living things; but there are now known a multitude of carbon compounds which have not been found in organisms, but are genetically so intimately related to those which have been there produced, that they can not be excluded from the same group. As a single example I may cite the hydrazones,

by means of which sugars of a great variety have been identified and their relationships understood; yet no hydrazone, so far as we know, occurs in plants.

Again: There are many carbon compounds which, normally produced in living beings, have also been produced by synthesis outside the influence of life. As a single example of such I mention oil of wintergreen, which normally occurs in birch bark and wintergreen berries, but which is now produced commercially by synthetic methods. Many other essential oils are likewise manufactured.

Most organic substances therefore belong to a group more correctly known as carbon compounds, whose connection is very intimate. Among these compounds the most stable one, anhydrous carbon dioxide, CO_2, naturally finds a place. It occurs in nature, but is produced also as a result of destructive metabolism in organisms. Heretofore it has been called an inorganic substance. Furthermore, water occurs in nature, but is frequently produced by and in organisms. It too has been called inorganic. But the substances antecedent to these two in the descending scale of oxidation in the organism were called organic. The illogical nature of such a distinction is evident, at least in the case of CO_2.

I do not conceive it to be possible to use the terms organic and inorganic with scientific accuracy, because they are not scientific; but if we endeavor to use them as correctly as our present knowledge demands, we can not say that the food of green plants is inorganic, except in so far as the mineral salts, and possibly the water, are concerned.

This, however, may be considered a mere juggling of words, though I look upon the correct use of words as of especial importance in teaching. I propose to show, however, that neither CO_2, H_2O, nor mineral salts can properly or logically be considered the *food* of green plants.

When these substances are obtained by chlorophyll-bearing cells, as they are from the atmosphere and from the soil respectively, they do not exist as two independent compounds, nor does the CO_2 simply enter into solution in the water. On the contrary a new substance, H_2CO_3, is formed, which is carbonic acid.

Carbonic acid is far more readily decomposable than either of the stable compounds from which it originates. By the action of the protoplasm of the chlorophyll bodies, under the

influence of light of sufficient intensity, this H_2CO_3 is reduced, and a new compound of carbon is formed, of whose nature we are yet ignorant. It is supposed, on various *a priori* and experimental grounds, that this is one of the aldehyde group, probably formic aldehyde, CH_2O. The experiments of Bokorny upon the nutrition of Spirogyra seem to indicate the correctness of this idea. He endeavored to ascertain whether this plant could be supplied with any members of the aldehyde series in solution, and could then continue the same process or produce the same result as when it was supplied with H_2CO_3. Several of the simpler members of the aldehyde group proved deleterious,[2] but direct experiments with methylal ($C_3H_8O_2$) succeeded. This substance was supplied to starved, and hence starch-free, Spirogyra filaments in pure water, and access of CO_2 was prevented. With these conditions, under normal illumination, starch was quickly formed.[3] Not satisfied with this however, Bokorny succeeded[4] in obtaining the same result under similar conditions by using a nutrient solution containing 1:100 or 1:1000 of sodium oxymethylsulphonate, CH_3NaSO_4, which easily decomposes at a low temperature into formic aldehyde and sodic sulphite, $CH_2O+NaHSO_3$. Boehm's experiments with cane sugar[5] and, later, Arthur Meyer's[6] with levulose, dextrose, galactose, mannite and glycerin, show that the ordinary parenchyma cells of the green leaf can form starch from solutions of these substances supplied to starved (starch-free) leaves.

In view of these results, which do not stand alone, and are also supported by E. Fischer's work on the synthesis of sugars,[7] it can hardly be doubted that complex carbon compounds

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[3] Loew und Bokorny: Chem.-physiol. Studien über Algen. Jour. f. pract. Chem. XXXVI (1887). 272-291.

[2] Bokorny: Ueber Stärkebildung aus verschiedenen Stoffe. Ber. d. deutsch. bot. Gesells. VI (1888). 116-120. See also his Welche Stoffen können ausser Kohlensäure zur Stärkebildung in grünen Pflanzen dienen? Landw. Vers. Stat. XXXVI (1889). 229-242.

[4] Bokorny: Ueber Stärkebildung aus Formaldehyde. Ber. d. deutsch. bot. Gesells. IX (1891). 103.

[5] Boehm: Ueber Stärkebildung aus Zucker. Bot. Zeit. XLI (1883). 33-38, 49-54.

[6] Meyer, A.: Bildung der Stärkekörner in den Laubblättern aus Zuckerarten, Mannit und Glycerin. Bot. Zeit. XLIV (1886). 81-88, 105-113, 129-137, 145-151.—Cf. also Laurent: Sur la formation d'amidon dans les plantes. Bruxelles, 1888; *fide* Bokorny.

[7] Fischer, E.: Synthesen in der Zuckergruppe. Ber. d. deutsch. chem. Gesells. XXIII (1890). 2114. See also: Synthese des Traubenzuckers. l. c., p. 779.

arise in the manner indicated by von Baeyer in 1870,[8] viz., by condensation of formic aldehyde. Heretofore, following Sachs' path-breaking researches,[9] it has been believed that starch was not only the first visible product of this process, but that almost or quite all the material manufactured by the chlorophyll body passed at one time or another into the form of starch. The recent work of Brown and Morris,[10] however, proves conclusively that this is not the case. "It is far more probable," they say,[11] "that starch is only elaborated within the cell when the supply of nutriment is in excess of the cell requirements, and that most of the assimilated products never pass through the stage of starch at all." Their experiments "point to the somewhat unexpected conclusion that, at any rate in the leaves of the Tropaeolum, cane sugar is the first sugar to be synthesised." This accumulates in the cell-sap, and when its concentration "exceeds a certain amount . . . . starch commences to be elaborated by the chloroplasts." They add: "Our analyses point to the cane sugar being translocated as dextrose and levulose, and the starch as maltose, the latter process only taking place when the starvation of the cell has induced the dissolution of the starch."

The substances standing between formic aldehyde, CH_2O, and the sugars produced by this process are, however, not certainly known, and from the inherent difficulties surrounding the investigation, as well as the instability of the substances themselves, may not be known for a long time.

For our present purpose the only question of importance is whether the C, H, and O are, either in the form of H_2CO_3, or after partial reduction, or in their nascent condition after dissociation, combined with the protoplasm which later forms starch, as is urged by various writers. If they are so combined, then H_2CO_3 must be looked upon as a *food*, and the process be termed assimilation in accordance with long usage in animal physiology.

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[8] BAEYER, A. VON: Ueber die Wasserentziehung und ihre Bedeutung für das Pflanzenleben und die Gährung. Ber. d. deutsch. chem. Gesells. III (1870). 63-75.

[9] SACHS: Ueber den Einfluss des Lichtes auf die Bildung des Amylums in den Chlorophyllkörnern. Bot. Zeit. XX (1862). 365-373.—Also, Ueber die Auflösung und Wiederbildung des Amylums in den Chlorophyllkörnern bei wechselnder Beleuchtung. Bot. Zeit. XXII (1864). 289-294.

[10] BROWN & MORRIS: The chemistry and physiology of foliage leaves. Jour. Chem. Soc. LXIII (1893). 604-677.

[11] Loc. cit. p. 673.

1. Destructive metabolism in plants results in the decomposition of protoplasm, with the production of CO_2 and H_2O. The residue may probably be again combined with C, H, and O, to rebuild protoplasm. Can this be done in the green leaves? Is it accomplished there? For such repair we know that carbohydrates disappear, and that such repair is going on in all living parts, whether green or not. It is conceded that in no part not green could H_2CO_3 be used in this way. Presumptively, therefore, it is not so used in these parts.

2. The amount of H_2CO_3 used by the plant under normal illumination is much greater than necessary to repair waste, and also much greater than the amount necessary to form the starch which appears in the chloroplast. To account for this, on the supposition that starch and similar carbohydrates arise in the chlorophyll body by the actual decomposition of protoplasm, it is necessary to suppose that in the chlorophyll body the protoplasm combines C, H, O, N, and S, at least, *de novo*, to form proteids; or else that the products remaining after the starch is formed from protoplasm are continually rebuilt from the C, H, and O, derived from H_2CO_3. This is a much more complicated process than polymerization of formic aldehyde, and it is by so much more improbable. Moreover it rests, as I believe, upon insufficient observation and faulty deductions from these observations.

Note the point: That carbohydrates *may* arise by the decomposition of protoplasm is, since it is irrelevant, not denied; but that the recomposition, the repair, of the protoplasm so broken down, is accomplished by the direct use of H_2CO_3 is highly improbable.

3. On the view that starch arises only from the decomposition of protoplasm, it is impossible to conceive of any reason why starch is absent from some spermaphytes and from the fungi in general. They are supplied often with food in excess; in favorable circumstances the protoplasm is abundant and active, but however abundant the food or active the protoplasm it never decomposes into starch.

We shall harmonize vegetable physiology best with animal physiology by taking a different view of these processes, one which is not opposed by any observation yet made, so far as I know, and one which is from the chemical side highly probable.

The process in my view is this: Assuming a supply of

CO_2 and H_2O in the presence of chlorophyll bodies furnished with radiant energy of sufficient intensity, there occurs a rearrangement of the molecules of C, H, and O into some simple compound, probably formic aldehyde. By definite changes, probably polymerization, this becomes more and more complex, until finally one of the higher carbohydrates is produced, generally one of the sugars.

I believe that these changes occur through the action of the living protoplasm of the chlorophyll body, but that the H_2CO_3 *is not brought into such relation to the proteid molecules as to form any part of them.* The energy necessary to accomplish the work is supplied in the form of light. The chlorophyll of the chromatophore acts as an absorbent of the rays which are useful in doing the work, as Timiriazeff has shown,[12] and not as a shield.

The process here described has been called "assimilation," "assimilation proper," and "assimilation of carbon." I think that none of these terms is appropriate.[13] Assimilation has been long used in animal physiology to designate the appropriation of digested food by the different tissues, and its conversion into the substances of those tissues. In that general sense it ought to be used in vegetable physiology, or, if it can not be so used, it ought not to be used at all. We have an opportunity to use it so, if we apply it to those changes by which the complex carbon compounds produced by the green cells are appropriated by the various tissues, and made a part of them. Moreover, since in many instances the reserve food is in a solid form, there is in plants a process of *digestion* by which this solid food is altered and dissolved in order that it may be assimilated.

For the process of formation of complex carbon compounds out of simple ones under the influence of light, I propose that the term *photosyntax* be used.[14] The protoplasm, by the

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[12] TIMIRIAZEFF: Enregistrement photographique de la fonction chlorophyllienne par la plante vivant. Compt. Rend. cx (1890). 1346–7.

[13] Cf. WIESNER: Elemente der wiss. Botanik I. 232. "Unter Assimilation versteht man gegenwärtig in der Pflanzenphysiologie die Umwandlung der Kohlensäure und des Wassers in organische Substanz. . . . Diese Auffassung stimmt mit der älteren, in der Thierphysiologie noch immer herrschenden, derzufolge Assimilation die Umwandlung der aufgenommenen Nahrungsmittel in die Bestandtheile der Gewebe bedeutet, nicht überein."

[14] WIESNER: l. c., p. 332: "Es scheint aber bei der im Texte gegebenen Begriffsumgrenzung an einem Worte zu fehlen für jenen wichtigen Process, den man bisher als Assimilation bezeichnete."

aid of light, marshals the molecules into new array and brings bodies of them together into new forms, as the individuals of an army are arrayed in companies, and companies drawn up into regiments. I have carefully considered the etymology and adaptation, as well as the expressiveness, of the word proposed, and consider it preferable to photosynthesis which naturally occurs as a substitute. Its derivation is evident: *φως*, light; *συντασσειν*, to put together, to arrange, to organize.

This power, which is possessed by green plants alone, is a power over and above that which any animal possesses, except possibly those which may contain chlorophyll. (In most instances where chlorophyll has been found in animals, it has been shown either to be derived from ingested plants, or to be due to a symbiotic relationship between plants and animals, and all the problematic cases may yet be so solved.)

Much of the food so produced is already in soluble form. But carbohydrate reserve food often appears in solid form, particularly of starch and cellulose. How is such food utilized? Manifestly there must first be its alteration into a soluble condition. This is accomplished by the agency of alterative enzymes. From the action of diastase on starch a sugar, maltose, results, which may be translocated and utilized directly in repair and growth. Cellulose is altered and dissolved likewise. Even the already soluble cane sugar produced by photosyntax needs to be changed into dextrose and levulose in order to be translocated readily. What are these changes but *digestion?*

Under this view the nutrition of green plants resolves itself into three processes, photosyntax, digestion, and assimilation. Photosyntax deals only with carbohydrates; digestion and assimilation with all classes of foods.

Photosyntax is the synthesis of complex carbon compounds out of carbonic acid, in the presence of chlorophyll, under the action of light.

Digestion consists in chemical change and solution of the solid foods. It is due in large measure, perhaps entirely, to the action of alterative enzymes.

Assimilation is the conversion of the foods into the living or mechanical substances of the plant tissues for repair of waste and growth.

Food is the physiological term for all substances capable of

direct assimilation or of digestion and assimilation. It includes the carbon compounds produced by photosyntax and many other substances, but is not applicable to CO_2 and H_2O, which are built into carbohydrates.

By these slight yet important changes in terminology we bring ourselves into harmony with the present knowledge of animal physiology, and have a much more intelligible and intelligent point of view from which to discern further truths regarding plant nutrition.

University of Wisconsin.

The bacterial flora of the Atlantic ocean in the vicinity of Woods Holl, Mass.

A contribution to the morphology and physiology of marine bacteria.

H. L. RUSSELL.

WITH PLATE XXXVI.

(Continued from p. 395.)

General biological features of the different organisms.

Zymogenic properties.

The majority of the bacteria isolated at Woods Holl belong to the liquefying group of micro-organisms and one of their fermentative actions is demonstrated in the production of a peptonizing enzyme that slowly liquefies gelatin. The digestion of the casein in milk cultures also attests the production of ferments that change the insoluble proteids into soluble peptones.

Pathogenic properties.

From the frequency with which bacteria are found in the water and mud of marine areas, it might be presumed that the organisms in question had no pathogenic properties but were purely saprophytic in their nutritive adaptation. This presumption however is not warranted on *a priori* grounds and it becomes necessary in working out the full life history of a micro-organism to test the relation of the germ as to its pathogenic properties. For this purpose, white rats were inoculated with one cc. of freshly grown bouillon cultures of the

different predominating forms but in no case was there any evidence that would lead one to think that any of the species tested possessed any pathogenic peculiarities.

Relation to gaseous environment.

Of the different forms isolated this season, almost all are decidedly aerobic. No growth takes place in plate cultures covered with sterilized mica sheets and the manner of growth in gelatin tubes demonstrates their predilection for oxygen. Only one species, B. litorosus, manifested any indifference to its gaseous surroundings. This species thrived quite as well along inoculation track as superficially, and in cultures prepared according to Buchner's pyrogallic acid method, a marked growth was to be noted in nutrient bouillon.

Effect on nitrate solutions.

The effect of bacteria upon the nitrogen-containing compounds is an important one. The fertility of soils depends in a large degree on the oxidizing action of certain bacterial forms. These convert the ammoniacal compounds into the more available nitrites and nitrates. Beside these oxidizing agents, however, there are a large number of germs that possess the antagonistic property of reducing these salts to simpler substances. The Franklands[10] and Jordan[11] have studied a number of forms that were isolated from the soil and the water supplies and noted their ability to reduce nitrate solutions to both nitrite and free ammonia.

The species now under discussion were also subjected to a similar line of experiment to see if they had any effect on the nitrates that might be in marine waters.

The nitrate solution used as a nutrient medium had the following composition: 1^{grm} pept. sicc. (Merck's); 1.01^{grm} KNO_3 (c.p.); 1000^{cc} Lake Michigan water.

This water was examined chemically and no trace of nitrogen in the form of nitrite was to be found. Erlenmeyer flasks containing one hundred cubic centimeters of this solution were used for cultures and after inoculating them with the various forms of micro-organisms they were incubated at 35°C. for a period of twenty-four hours and then analyzed for nitrites by the sulphanilic acid and naphthylamine hydrochlorate test.

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10 Zeits. f. Hyg. VI. 373.
11 Rep't Mass. State Bd. of Health. 1890.

In each case a marked reaction was noted, showing that the nitrate solution had been reduced and that nitrites were present in varying amounts. After four days' incubation at 35°C., the cultures were analyzed quantitatively for U as nitrite by colorimetric standards with the following results:

Total am't of N as KNO in culture solution,	14.00	parts in 100,000.	
N as KNO_2 in culture of Bacillus	limicola,	1.26	" " "
" " " " " " "	pelagicus,	2.8	" " "
" " " " " " "	maritimus,	2.1	" " "
" " " " " " "	litorosus,	2.3+	" " "

This indicates that the amount of nitrogen converted into nitrite from nitrate as a result of four days' growth of bacteria is by no means inconsiderable; in one case, B. pelagicus, reaching one-fifth of amount available. The marked difference to be noted in the amount reduced by B. limicola and B. litorosus is not to be explained by the difference in the rapidity of growth but is due to relative differences in reducing powers. At 35°C., B. litorosus grows much more slowly than at the ordinary temperature of the room, while the reverse is true of B. limicola. This relative difference in rate of development is however in inverse ratio to the amount of nitrogen reduced and shows that the denitrifying ability of the two germs differs to a considerable degree.

In order to determine whether the reduction process is carried on until free N or NH_4OH is produced, another culture test was made. The production of NH_4OH from nitrate can not be recognized by nesslerization as it is impossible to distinguish between NH_4OH that might come from the organic N in the peptone and that from the nitrate or nitrite, but by using a known amount of nitrate as a culture medium and then determining the amount present at the end of experiment, one is able to ascertain whether any considerable percentage has been reduced.

A normal solution of $NaNO_2$ was made, to which one per cent. of dry peptone was added. This was used as a culture medium and cultures of the several forms were examined as to amount of nitrite present after they had incubated for a period of five days. Growth of germs was evident in cultures but in no case was there any diminution of the amount of nitrite present, so the conclusion was evident that while the several species here described were able to reduce nitrates to nitrites, the later stages of the reduction process of nitrate to gaseous N were not carried on by these forms.

Experiments on insolation.

Although the fact that direct sunlight has a deleterious effect upon bacterial life in general has been known for a number of years[12] the full significance of this has not been generally appreciated until very recently. Carefully conducted experiments have shown that many of the pathogenic forms are profoundly affected by direct insolation not only when they are in a vegetating but in a quiescent spore stage as well.

The marine species isolated at Woods Holl have been tested in order to see whether forms naturally saprophytes were as easily affected as those accustomed to a parasitic mode of life.

Bouillon cultures not more than twenty-four hours old were used as seed. From these control gelatin plates were made by using one loopful of diluted culture. Two parallel sets of bouillon tubes, each containing two or three cc. of fluid, were also prepared by using one loopful of culture as seed. One of these was then wrapped in several folds of black tissue paper, care being taken to insert small pellets of cotton batting between the black paper and the glass of the tube, so as to diminish the effect of heat absorption and conduction to culture liquid as far as possible. These parallel sets of cultures were then exposed to the effect of direct sunlight during the day. At the close of the experiment, the culture tubes were filled with sterile gelatin and plate cultures made, so that the total number of germs could be directly ascertained, and compared with the control plate that showed the approximate number originally seeded.

Results of experiment were as follows:

Series inoculated and exposed to direct sunlight.
April 10th, 9 A. M. Sky clear, temperature varied from 15–21° C.
April 11th, sky cloudy all day.
April 12th, sky clear all day, temp. from 21–25° C.
April 13th, sky clear (cloudy from 1–3 P. M.), temp. 20–23° C.

Series planted on April 14th. Bouillon in "darkened" cultures appeared turbid with bacterial growth when unwrapped; the "exposed" tubes were perfectly clear and apparently unchanged. These tubes were now filled with sterile gelatin and plate cultures made with the following results:

NAME OF GERM.	NO. OF GERMS PLANTED AS "SEED."	NO. OF GERMS IN DARKENED CULTURE.	NO. OF GERMS IN EXPOSED CULTURE.
Bacillus maritimus	15	Several thousand	0
Bacillus litorosus	25	Several thousand	1
Bacillus pelagicus	420	Innumerable	0

[12] Downes & Blunt, Proc. Roy. Soc. 1877.

This confirms the work of other observers and shows that marine organisms are likewise susceptible in a high degree to the direct rays of solar light and that in a vegetative condition, they are easily destroyed in this way.

Distribution of species.

The distribution of species may be considered in two ways: first, as to area covered or superficial distribution; second, as to depth or bathymetrical range. The region examined at Woods Holl covered a larger area than at Naples, but the opportunity for determining the bathymetrical range was unfavorable owing to the extreme shallowness of the sea at this place.

The observations this season cover rather more than 100 square miles of the region of Buzzard's Bay and Vineyard Sound. The water forms were found to be distributed throughout the water masses very generally, as was likewise the case with those species indigenous to the mud.

Through the kindness of Prof. Wm. Libbey, Jr., opportunity was offered for the collection of material from the sea bottom that was secured by him on board of the U. S. Fish Commission schooner *Grampus*, at a distance of one hundred miles from mainland (New Bedford). The mud, consisting of globigerina ooze, was taken at the depth of 450^{ft} on the edge of the great continental platform that skirts the eastern coast of the United States. Only two samples were collected, but these sufficed to show that two of the more common mud forms that were to be found nearer the shore were also inhabitants of this locality. This instance, although isolated, suffices to show that the forms found in the mud are not locally distributed, but are spread over a considerable extent of the sea bottom.

This point is more strongly brought out when we compare the bacterial flora of this side of the Atlantic with that of the Mediterranean. Bacillus limosus was one of the most prevalent of the mud forms that was isolated in Mediterranean waters, and this same species has been identified by comparison of pure cultures brought from Naples with a form that is a common inhabitant of the sea slime at Woods Holl. The probable range of this cosmopolitan species can only be conjectured. It is a common form at Naples at the depth of 3,500^{ft}, and was also found abundantly on this coast as well as in the samples taken on the *Grampus* at the distance of 100 miles from land. Its presence at these three isolated localities testifies that its distribution is very general in the Atlan-

tic at least. Aside from this species, another mud form was secured on the *Grampus* that bore a very close resemblance to B. granulosus, a prevalent Neapolitan species. Careful comparison on same culture media of the germs from the two sources showed only slight differences, but these were scarcely more than would be expected of specimens coming from widely separated localities.

Concerning the distribution of those species that are common to this locality but unknown in the Mediterranean bottom, some observations are to be noted. First there is a marked difference as to the habitat of different species. Some are found solely in the mud layers, others are common to both water and mud.

Bacillus limicola, a common chromogenic species inhabits exclusively the ground layers of the sea bottom. In the vicinity of Woods Holl, it is a common form and was found in shallow places adjacent to the coast as well as in the deeper mud layers at a distance of ten to fifteen miles from land.

Three other forms, B. pelagicus, B. maritimus and B. litorosus which comprise, with the above mentioned species, the major portion of the bacterial flora of this locality, were found in both the water and the underlying ground layers. These were distributed throughout the water at all depths and B. pelagicus and B. maritimus were abundant in the samples of mud taken on the *Grampus* at a distance of 100 miles from land and in 450 feet of water.

Karlinski[18] has put forth a theory based upon the examination of one of the fresh water lakes in Bosnia that there is a horizontal zonary distribution of bacterial forms in water masses. He found, even within a vertical range of seventeen meters, a marked separation of the bacteria according to species. Forms common at the surface disappeared entirely in the deeper layers and were replaced by species peculiar to submerged strata. These results contravene those obtained at both this locality and at Naples. Here the study of the bathymetrical range of the different species has been limited on account of the shallowness of the sea, but the opportunity afforded by the dredgings from the *Grampus* showed that two forms, B. pelagicus and B. maritimus, were present in abundance at the depth of 450 feet as well as in the mud banks on the shore.

Much more favorable conditions for studying this question

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[18] Loc. cit.

were had at Naples as the depth of the sea at this point is not inconsiderable.

Three of the most prevalent forms found in the Mediterranean sea bottom showed a vertical range exceeding 3,500^{ft}, for they had not disappeared from cultures made from mud taken at this depth, and it is probable that their bathymetrical range was even considerably greater than this.

Concerning the relation between the superficial strata and extreme abysmal depths, we know nothing. If the relation between the higher forms of animal life hold in reference to bacterial forms, the presumption would be that there is a marked difference as to species between these layers. But such an analogy is inadmissible unless based upon observations, and these as yet are lacking.

University of Wisconsin.

(*To be concluded.*)

Plants hurt by a late freeze.

P. H. ROLFS.

In observing the effects of a frost in late spring many strange freaks are noticed. On the night of March 4, 1893, the thermometer went down to 29° F. at Lake City, Florida. The opinions as to whether harm was done were as various as the locations heard from. Closer observations showed that the following plants had suffered:

The variety of *Brassica oleracea*, known as "collards," is extensively grown for the kitchen and market. With considerable surprise I found that the young plants which had been set out had their larger leaves frozen. Further search showed the older plants that had shot up to flower drooping over. These racemes did not recover.

The largest and most beautiful of our wild violets, *V. sagittata* Ait., had the expanded portion of the petals, and in some cases the stigma frozen. Where, however, there was a slight protection, as a clump of saw palmetto or a blue berry bush, no harm was done.

Of the ornamental trees, the China tree, *Melia Azederach* L., suffered the most severely. It had made a vigorous growth; some young shoots were five or six inches long. All that were on low limbs less than eight feet from the ground were cut back to last year's wood, while those that were twelve feet or more from the ground were left unharmed.

Of the genus *Citrus* both *C. aurantium* L. and *C. vulgaris*

suffered and with scarcely any perceptible difference. If there was any, the favor was with the former, the sweet orange. The damage was confined to small trees not in bearing. The flower buds, not having opened on bearing trees, were unhurt.

The "zonale" geraniums exposed had leaves cut to the main stem.

On small trees of the prickly ash, *Xanthoxylum Carolinianum* Lam., the young growth of three inches was cut back to the wood; but when the tree was twenty feet or more tall the new growth was not hurt except on very low branches.

In the case of the common English peas there was quite a freak; the pods of a certain size were killed, while none of the rest of the plant sustained any injury.

Some of the earlier varieties of the peach had set young fruit; this was frozen, while the leaves remained entirely unhurt. All the fruit that had set and the open blossoms as well as those nearly open were killed.

The Kelsey plum in some cases had formed fruit which was frozen, while those trees that had not blossomed were left unharmed.

On *Prunus umbellata* Ell. the young leaves, and a very few of the flowers, showed signs of frost, but the leaves revived and some time later showed scarcely any signs of injury.

On the Le Conte pear none of the leaves were entirely frozen but many were frozen half way to the midrib. The blooms were not hurt excepting those that had receptive stigmas. As these trees are very liberal setters, I believe the most liberal, the damage to their crop was not perceptible.

The common old field blackberry, *Rubus cuneifolius* Pursh., had taken advantage of the three weeks of spring time and sent out young growth to the length of five inches; this was cut back to the old hard wood. Only a few flowers had opened and these were unhurt, as were also the flower buds and peduncles.

The crape myrtle, *Lagerstrœmia Indica*, had its young shoots cut back to last year's wood.

The large birds nest thistle, *Cirsium horridulum* Michx., that grows all winter in the open field, could not stand this sudden fall in temperature; the upper and projecting leaves all hung down but the vital portion and the lower leaves were not hurt in the least.

Vaccinium nitidum Pursh had the open corolla, the exserted stigmas and the old leaves frozen; the young leaves, unopened corollas and small fruit were not hurt.

Vaccinium tenellum Ait. had the expanded corolla, exserted stigmas, young leaves and newly formed stems frozen. The young stems were two or three inches long. This species is evergreen with us.

It is curious that the old leaves on V. nitidum were frozen while on V. tenellum the young leaves suffered.

Pinguicula lutea Walt. on the moist pine barrens had the scapes frozen down to the surrounding débris. The scape was frozen to within four inches of the ground and the rest left unhurt.

Young tobacco plants where not protected were killed, but the beds in hammocks or on the edges of hammocks escaped.

Poke weed, *Phytolacca decandra* L., had grown to be a foot or more high, and was cut back to within four inches of the ground. Specimens that were somewhat protected wilted in the sun but recovered in a day or two.

Young beets that were about six inches high had the outer and higher leaves frozen.

Mulberry trees, *Morus alba* L., had grown enough to make a fine shade. The frost killed the younger leaves entirely and the older leaves were more or less hurt, so that it was difficult to find a perfect leaf within ten feet of the ground.

The figs, *F. carica* L., had to make a new start. They had made vigorous growth and the young figs were about the size of a large hazelnut.

Tradescantia zebrina was entirely frozen.

Paspalum læve had some leaves seven inches long. The outer and more exposed leaves alone sustained injury.

The above notes cover quite completely the plants that sustained injury from that frost.

Conclusion.—Most plants are very sensitive to frost during the period of rapid growth.

Portions of plants that have passed through colder weather may be injured by less frost under different conditions (e. g. *Vaccinium nitidum*, *Cirsium horridulum*). Of the twenty-five species more or less hurt by the frost, three are annuals, three biennials, and nineteen are perennials; eleven are herbs, five are shrubs, and nine are classed as trees. Of the fourteen shrubs and trees four are evergreen and ten deciduous.

Lake City, Fla.

Popular American plant names. II.

FANNY D. BERGEN.

The present paper embraces the common names of North American plants, from Ranunculaceæ as far as Umbelliferæ, that have been added to my list since the publication of a preliminary list in the Journal of American Folk-Lore for April–June, 1892. The names under the remaining orders of phanerogams and a few names of cryptogamous plants will follow at an early date.

I would like once more to call the attention of botanists and folklorists to the interest and value of a somewhat complete collection of the kind which has been made in England, and to request that readers who are interested in the matter will kindly forward to me any names which they may know.

A large proportion of those which follow have been gathered from correspondents or by oral communications, though some have been taken from published local floras which are not readily accessible to botanists in general.

It is impossible publicly to thank every individual who has contributed to my collection of plant-names, but the following persons have extended such substantial assistance that it would be unfair not to mention here their names in connection with the work and cordially to thank them one and all for their generous help:—

Alger, Miss A. L.
Allen, J. A.
Barnes, Prof. C. R.
Beauchamp, W. M.[1]
Bebb, M. S.
Bessey, Prof. C. E.
Blochman, Mrs. L. E.
Briggs, Prof. F. R.
Dugger, S. M.
Ganong, W. F.
Ganong, Mrs. W. F.
Hayward, Rev. Silvanus
Hoke, Miss N. C.[2]
Hosmer, A. W.
Millspaugh, Dr. W. F.[3]
Newell, Miss Jane H.
Owens, J. G.[2]
Robbins, Mrs. Mary C.
Robinson, Dr. Benj. L.
Robinson, Rowland E.
Seaver, Miss Eliza J.
Seymour, A. B.
Slosson, Mrs. Annie Trumbull
Thurston, Prof. C. O.
Thurston, Miss Helen S.
Tower, S. F.
Vroom, J.
Walden, Mrs. C.

[1] Most of the New York names were contributed by Mr. Beauchamp, either from his own observations, or from Torrey's early list of New York plants, or from Miss Cooper's *Rural Hours*.

[2] These valued correspondents have died within the past six months.

[3] Almost all the West Virginia names are taken from Dr. Millspaugh's *Flora of West Virginia*, or from his *Bulletin No. 23* of the West Virginia Agricultural Experiment Station.

Walker, Francis A.
Whiting, Miss Margaret C.
Wilson, Prof. Andrew G.

RANUNCULACEÆ.

Clematis Virginiana, devil's hair. Va.
Anemone patens, var. *Nuttalliana*, crocuses (by town children) Del. Co., Ia.; Rockford, Ill.
April fools.[1] Rockford. Ill.
hartshorn plant, headache plant, gosling, prairie smoke, crocus. Minnesota.
Anemone Virginiana, thimble-weed. West Va.
Anemone nemorosa, Mayflower. E. Mass.
Hepatica triloba, squirrel cups. N. Y.; Ferrisburgh, Vt.
heart liverwort. N. Y.
noble liverwort. Buckfield, Oxford Co., Me.
spring beauty. N. Y.
Anemonella thalictroides, Mayflower. E. Mass.
Thalictrum dioicum, quicksilver weed. Penobscot Co., Me.
Caltha palustris, cow lily. Hingham, Mass.
cowslops. Ferrisburgh, Vt.
meadow buttercup. New England.
Aconitum napellus, Adam and Eve. Washington Co., Me.
Cimicifuga racemosa, rattle-weed. Banner Elk, N. C.

MAGNOLIACEÆ.

Magnolia acuminata, yellow linn. West Va.
Liriodendron tulipifera, white, yellow, or hickory poplar. West Va.
cucumber-tree. N. Y.
magnolia. White Haven, Pa.

BERBERIDACEÆ.

Berberis pinnata, Span. Leña amarilla (yellow wood), Santa Barbara Co., Cal.
Berberis aquifolium, Oregon grape. Ore.
Podophyllum peltatum, mandrake pear. N. J.

NYMPHÆACEÆ.

Nelumbo lutea, water lily. Peoria, Ill.
great yellow water lily. N. Y.
Nuphar advena, bonnets. Fla.
gold watch. Mauch Chunk, Pa. (name perhaps not general there).
yellow pond lily. Ferrisburgh, Vt.
hog lily. Concord, Mass.

[1] Perhaps because they blossom about April 1, and are afterwards sometimes snowed under.

SARRACENIACEÆ.

Sarracenia purpurea, watches. Atlantic City, N. J.
fever-cup. Grand Manan Id., N. B.
huntsman's cup, forefather's cup, New England.
dumb watches or watch. Cape May Co., N. J.

PAPAVERACEÆ.

Sanguinaria Canadensis, puccoon. Banner Elk, N. C.
puccoon root. Anderson, Ind.
coon-root. West Va.
white puccoon, N. Y.
Dendromecon rigidum, tree poppy. S. Barbara Co., Cal.
Romneya Coulteri, Matilija poppy. S. Barbara Co., Cal.
Platystemon Californicus, *Platystigma lineare*, } cream cups. S. Barbara Co., Cal.

FUMARIACEÆ.

Dicentra cucullaria, little boy's breeches. Central Iowa.
breeches flower. N. Y.
boys and girls. N. Y.
Dicentra Canadensis and *Dicentra cucullaria* called respectively (?)
ladies and gentlemen. Franklin Centre, P. Q.
girls and boys. Vt.
Dicentra Canadensis, wild hyacinth. N. Y.
Dicentra spectabilis, lady's ear-drops. Concord, Mass.
lady-in-a-boat. Franconia, N. H.

CRUCIFERÆ.

Dentaria laciniata, crow's foot. Anderson, Ind.
Dentaria diphylla, crinkle root. N. Y.
Draba verna, shad flower. West Va.
Hesperus matronalis, dame's violet. West Va.
Brassica sinapistrum, crowd-weed; Kraut-weed. West Va.
Brassica arvensis, water cress. West Va.
Capsella bursa-pastoris, pepper grass. Del. Co., Ia.; Concord, Mass.
shovel weed.[1] Penobscot Co., Me.
pickpocket. Ferrisburgh, Vt.
Lepidium campestre, Glenn-weed;[2] Glenn-pepper; crowd-weed. West Va.
Lepidium Virginicum, tongue grass. Del. Co., Ia.; Anderson, Ind.

[1] From the shape of the pods.
[2] So called from having first been noticed on the farm of a family named Glenn.

Lunaria biennis, gold-and-silver-plant. N. J.
Caulanthus procerus, } wild cabbage. Cal.
Caulanthus crassicaulis, }

CAPPARIDACEÆ.

Cleome spinosa, spider flower. West Va.

VIOLACEÆ.

Viola pedata, sand violet. Conn.
Viola pedata, pansy. Peoria, Ill.
snake violet; horse-shoe violet. Swansea, Mass.; Boston, Mass.
Viola pedata, var. *bicolor*, velvet violets, or (by children) velvets. Ga.
Viola palmata, roosters. Ferrisburgh. Vt.
Viola palmata, var. *cucullata*, Johnny-jump-ups. Banner Elk, N. C.
roosters. N. Y.
Viola Canadensis, hens. Ferrisburgh, Vt.
Viola tricolor, Johnny-jump-up. W. Mass.
battlefield flower.[1] Gordonsville, Va.

CARYOPHYLLACEÆ.

Dianthus barbatus, French pinks. Brunswick, N. Y.
bouncing Bet. Ferrisburgh, Vt.
Dianthus barbatus (scarlet, var.), scarlet lightning. Province Quebec.
Dianthus barbatus (white, var.), snow-flake. Province Quebec.
Saponaria officinalis, Boston pink. Poland, Me.; Wellfleet, Mass.
chimney pinks. N. H.
Silene cucubalus, rattle-box. Berkshire Co., Mass.
Silene laciniata, wild pink. S. Barbara Co., Cal.
Silene Armeria, dwarf French pinks. Brunswick, N. Y.
mock sweet William. S. Indiana.
old maid's pink. Canada and W. Mass.
Lychnis Githago, Licheta. Montpelier, Vt.

PORTULACACEÆ.

Portulaca grandiflora, moss. S. Indiana.
Claytonia perfoliata, wild lettuce.[2] S. Barbara Co., Cal.
Calandrinia Menziesii, mother's beauties. S. Barbara Co., Cal.

HYPERICACEÆ.

Hypericum proliferum, broom brush. West Va.
Hypericum perforatum, St. John. West Va.

[1] Because found so often on old battlefields, after the Civil War.
[2] Sometimes eaten by children as they would eat lettuce.

MALVACEÆ.

Malva rotundifolia, malice. Ferrisburgh, Vt.
Abutilon Avicennæ, American jute. West Va.
Hibiscus moscheutos, mallow rose. N. Y.

TILIACEÆ.

Tilia sp., daddy-nuts. Madison, Wis.

GERANIACEÆ.

Geranium maculatum, spotted geranium. Ferrisburgh, Vt.
Geranium Robertianum, wild geranium. N. Y.
Pelargonium tricolor, pansy geranium. Mooers, N. Y.
Pelargonium capitatum, rose-scented geranium; rose geranium; sweet-scented geranium. P. Quebec, Canada.
Oxalis acetosella, sheep sorrel. Jones and Del. Co., Ia.
Oxalis violacea, sheep sorrel. Peoria, Ill.
Oxalis corniculata, var. *stricta*, sheep sorrel. Peoria, Ill.; Ferrisburgh, Vt.; Anderson, Ind.
lady sour-grass. N. J.
Impatiens pallida, silver weed. N. Y.
Impatiens fulva, celandine. Buckfield, Me.; Ferrisburgh, Vt.
solentine. Penobscot Co., Me.
ear-jewel. Ferrisburgh, Vt.
wild celandine. Franconia, N. H.
wild balsam. Concord, Mass.
silver weed. N. Y.

RUTACEÆ.

Ptelea trifoliata, wafer ash. West Va.

RHAMNACEÆ.

Rhamnus Californica, wild coffee; bearberry. S. Barbara Co., Cal.

VITACEÆ.

Vitis cordifolia, fox grapes. Ferrisburgh, Vt.
Vitis rupestris, sand grape; sugar grape. West Va.
Vitis vulpina, bull grape. Ala.
Ampelopsis quinquefolia, five-fingered ivy; American joy. N. Y.

SAPINDACEÆ

Acer saccharinum, hard maple. Jones, Linn, and Del. Cos., Ia.
Acer rubrum, soft maple. Jones, Linn, and Del. Cos., Ia.

ANARCARDIACEÆ.

Rhus glabra, senhalenac.[1] Ferrisburgh, Vt.
Rhus venenata, poison elder. Ala.

POLYGALACEÆ.

Polygala paucifolia, May wings. Conn.; N. Y.
gay wings. Ferrisburgh, Vt.; N. Y.
baby's slippers. W. Mass.
Indian pink. Montague, Mass.

LEGUMINOSÆ.

Baptisia tinctoria, shoo fly. West Va.
Baptisia lanceolata, gopher-weed. Ga.
Crotalaria sagittalis, wild pea.[2] Ia.
Lupinus littoralis, Chinook liquorice. Washington, D. C.
Robinia pseudacacia, white locust; yellow locust, N. Y.
Robinia hispida, honey locust. N. Y.
Desmodium rotundifolium, hive vine. West Va.
Desmodium Canadense, beggar's lice. Concord, Mass.
Lathyrus odoratus, posy peas. Franconia, N. H.
Apios tuberosa, ground-pea. N. E.
Cassia Chamæcrista, magotty boy bean: N. Y.
Gleditschia triacanthus, thorn locust. N. Y.
Richardsonia scabra, Mexican clover. Ala.

ROSACEÆ.

Prunus Americana, hog plum. Tex.
Prunus Chicasa, mountain cherry. Md.
Prunus pumila, sand cherry. Common among nurserymen.
Prunus Pennsylvanicus, bird cherry. Penobscot Co., Me.
Prunus demissa, choke-cherry. Neb.
Prunus Caroliniana, cherry laurel; wild orange; mock-orange; wild peach. Southern States.
evergreen. Ga.
Prunus ilicifolia, Spanish wild cherry; mountain evergreen cherry. Cal.
islay. S. Cal. and W. Arizona.
Prunus fasciculata, wild almond. So. Utah.
Spiræa salicifolia, queen of the meadows. N. Y.

[1] Name of the Saranac River comes from this.

[2] A "loco-plant," producing in horses coma, or a loss of consciousness with power of locomotion still retained. Finally emaciation and death. Dr. M. Stalker, Ames, Ia.

Spiræa lobata, sweet William. Brunswick, N. Y.
Gillenia stipulacea, Injin physic. Banner Elk, N. C.
Rubus odoratus, thimble-berry. West Va.; N. Y.; Ferrisburgh, Vt.
Rubus occidentalis, blackberry. Ann Arbor, Mich.
black cap. N. Y.
Rubus villosus, "sow-tit" (teat). N. H.; Farrington, Conn.; Goshen, Conn.
finger berry; thimble berry. N. Y.
thimble berry. Ann Arbor, Mich.
Dalibarda repens, dew drop. N. Y.
Geum rivale, chocolate.[1] Buckfield, Me.; Franconia, N. H.
maiden hair. Brodhead, Wis.
Geum triflorum, Johnny smokers.[2] Rockford, Ill.
Potentilla Canadensis, sinkfield. West Va.
Agrimonia Eupatoria, stick seed; beggar's ticks. West Va.
Pyrus Americana, Indian mozemize; moose misse. Ferrisburgh, Vt.
Cratægus coccinea, thorn-bush. Penobscot Co., Me.
Cratægus coccinea, var. *mollis*, red haw. Gen. in Central States.
Cratægus Crus-galli, Newcastle thorn. N. Y.
Cratægus æstivalis, apple haw. Ala.
Cratægus brachyacantha, pomette bleue. N. W. La.; E. Tex.
hog's haw. N. W. La.; E. Tex.
Amelanchier Canadensis, snowy medlar. N. Y.
sugar-plum. Vt.
sugar pear. Orono, Me.
sugar berry. N. Woodstock, N. H.
sand cherry. Mont.
Adenostoma fasciculatum, chamise; chamise brush. S. Barbara Co., Cal.
Lyonothamnus floribundus, iron wood. Ids. of Sta. Catalina and Sta. Cruz, Cal.
Heteromeles arbutifolia, tollon; toyon. Cal.
California holly. S. Barbara Co., Cal.

CALYCANTHACEÆ.

Calycanthus floridus, sweet-scented shrub. No. O.
strawberry-bush. E. Mass.
Calycanthus glaucus, bubby-bush. Banner Elk, N. C.

SAXIFRAGACEÆ.

Saxifraga (*Virginiensis?*), lungwort. Calais, Me.

[1] Decoction of root sometimes used as a beverage.
[2] Applied at time of fruiting, when conspicuous with plumose styles.

Saxifraga Mertensiana, cocoanuts.[1] So. Cal.
Tiarella cordifolia, Nancy-over-the-ground. Mass.
white cool-wort. N. Y.
Mitella diphylla, false sanicle; fringe cup; fairy cup. N. Y.

CRASSULACEÆ.

Sedum Telephium, life of man. Concord, Mass.
Diamorpha pusilla, red moss. Hancock Co., Cal.
Cotyledon laxa, rock moss. S. Barbara Co., Cal.

HAMAMELIDÆ.

Liquidambar styraciflua, alligator-wood. W. Va.

MELASTOMACEÆ.

Rhexia Virginica, handsome Harry. Hanover, Mass.

LYTHRACEÆ.

Cuphea petiolata, tar weed. West Va.

ONAGRACEÆ.

Ludwigia alternifolia, seed-box. West Va.
Epilobium angustifolium, fire-top; burnt weed. Penobscot River, Me. (lumbermen).
Œnothera biennis, scurvish. Franconia, N. H.
fever-plant;[2] coffee-plant.[3] Eastern States.
king's cure-all. Southern States.[4]
Œnothera fruticosa, wild beet.[5] West Va.

CUCURBITACEÆ.

Cucurbita perennis, Chili cojote; calabazilla. So. Cal.
Megarrhiza Californica, man-in-the-ground.[6] S. Barbara Co., Cal.

FICOIDEÆ.

Mesembryanthemum æquilaterale, beach apple. S. Barbara Co., Cal.

Cambridge, Mass.

[*Reprinted from plates kindly furnished by the Journal of American Folk-Lore.*—EDS.]

[1] On account of having bulbs commonly dug up and eaten by children.
[2] Used as a diaphoretic in fevers.
[3] Infusion used as a drink in the harvest field.
[4] Used in domestic medicine.
[5] Used as a pot herb.
[6] So named from the enormous roots.

BRIEFER ARTICLES.

Natural history specimens in mails for foreign countries.—The following notice has lately been distributed to postmasters: The United States Post Office Department having submitted a proposition to so amend the universal postal convention of Vienna as to admit packages containing natural history specimens to the mails exchanged between countries of the postal union at the same postage rate and under the same conditions as apply to packages containing "samples of merchandise" in said mails, and said proposition having upon its submission to a vote of the countries composing the Universal Postal Union been rejected; the notice is hereby given that packages containing natural history specimens are not transmissible by mail to any country of the postal union (except Canada) except as *letters* upon which postage at the rate of five cents per half-ounce has been prepaid in full. . . .

The foregoing provisions do not apply to packages of natural history specimens addressed for delivery in Canada, the transmission of which is governed by the United States postal laws and regulations; nor to similar packages sent by "parcels post" to the countries named on page 930 of the United States *Official Postal Guide* for January, 1893. [These are: Bahamas, Barbadoes, Colombia, Costa Rice, Danish West Indies, Hawaiian Kingdom, Honduras, Jamaica, Leeward Is., Mexico, Salvador, British Guiana, and Windward Is.]

Postmasters will cause due notice of the foregoing to be taken at their offices.

By direction of the Postmaster-General, N. M. BROOKS, *Superintendent of Foreign Mails.*

EDITORIAL.

THE INCREASINGLY close organization of American botanists is a significant fact. In the beginning of their association the purpose was chiefly to cultivate personal acquaintance and to catch the inspiration that comes from an interchange of views. This has gone on until the great body of the working botanists of this country are thoroughly bound together by personal acquaintance and mutual esteem. A step further was taken when those interested in taxonomic nomenclature took advantage of their association to formulate a code of working rules, and thus turn into useful directions the energy that was being dissipated in the maintenance of differences. The next step was to adopt the co-operative plan of work, and with this idea the check-list

of the higher plants of the "manual range" has been prepared by a committee and referred to the Botanical Club for approval. In committee discussions and in those of the Club botanists have learned the value of a consensus of opinion, and have recognized that it is easier and far more effective to settle differences by arbitration than by war.

THIS LEADS us to speak of the relation of the principle of co-operation to the future of botanical work. The time has passed when any general botanical work should be prepared by a single individual, however capable that individual may be. Every work should appear with sufficient rapidity to insure completeness and uniform treatment. This is notably true in our most important systematic works, which have often been of such slow preparation that a whole generation has left them incomplete. Every botanist recalls the case of Dr. Gray's most elaborate works. Had the *Flora of North America* been pushed to completion by a group of botanists, it might not have been of equal excellence throughout, but it would have brought together all the information of the time, and established a definite point of departure for the subsequent study of all of our vascular groups. Had the *Synoptical Flora*, so fit a monument to our most distinguished systematist, called to its aid the rapidly increasing force of workers, it would now mark the second epoch of our knowledge of the North American flora, and would have had the masterly guidance of its projector, instead of being left, as it is, to an indefinite future. There is a time when details become so numerous that only organization can use them effectively. A general may be able to command a company better than any captain, but still he must be content to leave many details to others.

TO MARSHALL into orderly array all the known facts with reference to our North American flora is more than any one can do in a lifetime, and still all these facts must be brought together in the interest of progress. It is theoretically beautiful for one unusually capable systematist to traverse the whole field and monograph every group, but practically it is impossible. It is absolutely necessary to call in ordinarily capable workers and let them do the best they can. They may blunder, but they will surely get the facts into usable shape. No work pretends to be the last utterance upon any subject, but simply the foundation for future utterances, and it is always important that our information be kept current and within easy reach.

THE CO-OPERATION referred to involves not merely the allotment of work, but also the exchange of specimens and publications. It is impossible for all capable workers to reside at the greatest center of

material, but it is perfectly possible for those centers to equip them temporarily for work. That selfish hoarding of material which fears that some one else will get the benefit of it is not only contrary to the real scientific spirit but shows an entire lack of appreciation of the greatness of the field. It must be said that in this country, at least, almost every botanist is ready to open his collections and his library to all who know how to use them, and in so doing feels that he is advancing the interests of botanical science.

WHAT HAS BEEN SAID of co-operation in systematic botany obtains in almost every field of botanical work. It is a question whether any one man should prepare a complete work upon so young a subject as Physiological Botany, for it is impossible for him to examine the whole field, and certainly not in Morphology. Of course reference is not made to brief, compiled texts, but to monographic work. In this connection it may be said that a suggestion was made at the Madison meeting which would be immensely useful if carried out, namely, that botanists arrange for an exchange of index cards, each contributor being assigned certain publications for indexing, the cards being printed in uniform style and sent to all the others. This sort of co-operation would speedily lead to even more complete and effective organization of work.

IT IS CERTAINLY true that the progress of botanical science in this country, and in all countries, will be very much hastened by the completest possible organization of co-operative work.

CURRENT LITERATURE.

A new high school botany.[1]

A suitable botanical text-book for high schools seems to be the unsolved problem of publishers and teachers. The attitude of publishers is easy to understand, but that of teachers is not so simple. The only botanists who feel that a suitable book for such a purpose has been written are those who have written them, and the books in their own hands and in those of their own disciples are eminently satisfactory. Every good teacher has his own method, and it is not at all surprising that no one else expresses it exactly. Professor Spalding is an exceptional teacher and has produced an excellent book. It is intended to apply to the present condition of high school equipment and teachers and is surely a vast improvement upon "analysis." The

[1] SPALDING, VOLNEY M.—Guide to the study of common plants, an introduction to botany. 12 mo. pp. XXIII+246: Boston, D. C. Heath & Co., 1893.

book is a laboratory guide rather than a text-book, although it constantly associates form with function and gives frequent excellent summaries. It undoubtedly directs to proper methods of observation and seeks to cultivate the true scientific spirit. The serious question will be raised whether such a book should encourage the "actual state of things in most of our preparatory schools" or should show the same schools what the state of things ought to be in order to properly teach botany. The present book begins with an excellent series of studies of the organs of flowering plants; then considers the natural groups, beginning with algæ (Spirogyra and Vaucheria being used as types), and passes at once to the bryophytes, pteridophytes, and spermaphytes, paying increasing attention to groups as the advance is made. The theory of presentation is of course to cultivate the habit of proper observation with those large plant organs that are commonly known; in other words, to proceed from the complex to the simple. To many botanists this position will seem untenable. In the writer's experience the best results have been obtained by presenting the plant kingdom from the standpoint of its evolution, beginning with units of structure and function. Besides this, the morphology of the flower is impossible of conception except by approaching it by way of the lower groups.

Another question that can be raised concerning the book is the very scant attention it pays to thallophytes. Few types, well selected, are always to be preferred in elementary work to that large array of forms which is so common, forms which stand as so many isolated facts, and when observed, and sketched, and lectured upon are as barren as a sandbank. Too many types are confusing, but surely it would have been well to have introduced some of the great groups of fungi. Not a single reference even to the existence of such plants occurs, so far as we have observed!

All these, however, are questions which concern the theory and practice of the individual teacher. The teachers who use it, and we trust they will be many, will need to make a judicious selection of work from the pages. Blessed is he who knows what to leave out!

But the book is certain to be a very useful one. It is a long step in advance of anything we have for high schools. Professor Spalding is to be congratulated upon his book and the scientific spirit which pervades it.

We note some antiquated references which ought to be corrected in a future edition. Bower's Practical Botany is referred to as "Bower and Vines . . . Parts I and II," when they have long been combined in one volume and Dr. Vines' name has been withdrawn. Un-

derwood's "Our Native Ferns" is referred to as published at Bloomington, Ill., in 1882. This was the second edition, published by the author. But the author has not resided at Bloomington for ten years and the *fourth* edition of the book has lately been issued by Henry Holt & Co.

A course of practical elementary biology.[1]

Regarding this book we speak only of the botanical portion. It would have stated better the facts in the case if the author had called this a course of *impracticable* biology. We doubt whether any class of students ever pretended to work through the book. If they have, it surely must have taken some years, with daily work, to accomplish the feat. It strikes us rather as a thorough account of the morphology and physiology of the organisms chosen, interspersed with directions to study certain things or perform some experiments. For example, students are directed (p. 107) to "examine the nuclei of various cells, from the apical cell downward" in picric-acid-hematoxylin specimens of Chara in order to study the division of the nucleus! They are also directed (p. 136) to grow fern prothallia and study the history of their development, and likewise the development of the sexual organs. They are also asked to investigate the development of the pollen in Lamium album, the origin of the ovule and the structure of the egg apparatus.

The foregoing are only selected as examples of the impossible in an *elementary* course. We have little fault to find with the accuracy or mode of presentation of the matter of the book. It contains many useful hints for advanced students regarding the plants treated, which are yeast, protococcus, bacteria, mucor, penicillium, chara, the male fern, and dead nettle. Teachers also may be able to make use of it in suggesting work for classes. But it is in no sense suitable for beginners, at least in this country. If English students can as babes assimilate such strong meat they must be sons of Anak indeed!

Chapters in modern botany.[2]

This is one of the most charming and instructive books we have seen. If University Extension had done nothing for the people it could be credited with much good to botanists in bringing about the production of this book, which is one of a series of manuals issued by the Scribners. Its title tells just what it is; not a text book nor a

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[1] BIDGOOD, JOHN.—A course of practical elementary biology. Crown 8vo., pp. VIII + 353. figs. 226. New York, Longmans, Green & Co. 1883. $1.50.

[2] GEDDES, PATRICK: Chapters in modern botany. 12mo. pp. xii + 201. figs. 8. New York, Charles Scribner's Sons. 1893.

"botany" but a series of sketches "beginning indeed with some of the strangest forms and processes of the vegetable world [which] it is not proposed to exhibit merely as a vegetable menagerie of rarities and wonders, but for use as a convenient means of reaching . . . some general comprehension of the processes and knowledge of the forms of vegetable life . . . [and] some intelligent grasp of the experimental methods and reasoning employed in their investigation."

These "chapters" treat therefore of pitcher plants and other insectivorous plants, movement and nervous action in plants, the web of life (the relation between plants of different groups), the relations between plants and animals, spring and its studies, leaves, and finally suggestions for further studies.

Those who have read from Professor Geddes before need not be told that the style is charming and his expressions apt and striking. We can not begin to quote these; there is no end. We can only say that no teacher or lover of botany can in justice to himself fail to read these pages. We would also that this book might come into the hands of all the multitude to whom botany is yet mere herborization and the botanist a harmless gatherer of simples. To all it is most cordially commended as fully reaching its declared purpose.

Minor Notices.

IN CONNECTION with the botanical exploration of Costa Rica (*Primitiæ Floræ Costaricensis*, Durand and Pittier), Dr. F. W. Klatt has just published the Compositæ. Like other Central American states, the Eupatoriaceæ afford the most abundant display, the genus Eupatorium being represented by thirty species, ten of which are described as new. Fourteen other species are described as new, distributed among Senecio, Mikania, Viguiera,and several other genera. The total number of the list is 165.

TO THOSE interested in Diatoms, the volume[1] by Mills and Deby will be welcome. Some seventy-five pages are given to general information about diatoms, which might be much better without being first class, followed by analytical keys of families and genera (species not being considered), and rather incomplete directions as to collecting mounting, and photographing. The rest of the book (about 165 pp.) which is far the most important, indeed the indispensable, part of it, consists of the bibliography of the group, by Julien Deby.

PART III of John Donnell Smith's "Enumeratio Plantarum Guat-

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[1] MILLS, F. W. and DEBY, JULIEN.—An introduction to the study of the Diatomaceæ, with a Bibliography. 8vo. pp XI.+243: London, Iliffe & Son; Washington, The Microscopical Publishing Co., 1893.

emalensium" has just appeared. The very complete way in which Captain Smith is bringing to light this interesting flora leaves little to be desired. The explorations are thorough, the notes full, the specimens abundant. The material is a pleasure to study and to receive into the herbarium. It is fortunate that such collectors as the missionary, Theophilus Heyde, and his grandson, Ernest Lux, can be called upon. In the present distribution specimens also from W. C. Shannon and M. M. Macomb appear.

A STUDY of the venation of Salix has been published by Dr. N. M. Glatfelter and distributed in advance of the fifth annual report of the Mo. Bot. Garden. The species considered are those of Gray's Manual, and the author has provided valuable supplemental aid in their determination. Remembering how frequently leaf characters are the only ones obtainable in this genus, and also how important a group it is to the paleobotanist, venation characters should be made to reveal all they can. The species are separated into three groups, (1) those with secondary veins regular, (2) those with secondaries partly irregular, and (3) those with secondaries irregular. The secondaries have to be used, as the primaries are regular almost without exception. Three artotype plates illustrate the paper, having been photographed from the leaves by tramsmitted light.

"FOREST INFLUENCES" is the subject of Bulletin no. 7, from the Forestry Division of the U. S. Department of Agriculture. Mr. Fernow very conveniently gives a summary of conclusions in the introductory pages,some of which are as follows: *Influence on meteorological conditions*, (1) the general influence of the forest on soil temperatures is a cooling one; (2) the annual range of air temperature is smaller in the forest than in the open; (3) the mean temperature of the air in the tree-tops is rather higher than over open fields; (4) the forest affects the temperature just as any collection of inorganic obstacles to sunshine and wind, but as an organic being the forest may be also an independent source of heat; (5) the annual evaporation within the forests is about one-half of that in the open field. *Influence on climate of surrounding country*, (1) can only take place by diffusion of vapor of transpiration, (2) local air currents are induced by difference of temperatures of air within and without the forest, (3) the general air currents are cut off entirely in their lower portions by the forest. *Influence on water and soil conditions*, (1) deforestation augments and accelerates soil evaporation, and thus affects unfavorably the size and continuity of springs, (2) snow is held longer in the forest and its melting retarded, (3) surface drainage is retarded by the uneven forest floor, (4) the well-kept forest floor prevents erosion of soil better than even the close sod of a

meadow. *Sanitary influence*, (1) the claimed influence of greater purity of air does not seem to be significant, (2) protection against sun and wind and consequent absence of extreme conditions seem favorable, (3) the soil conditions of the forest are unfavorable to the production and existence of pathogenic microbes.

THE REPORT of the U. S. Microscopist for 1892 is devoted principally to edible and poisonous mushrooms. There are two other pamphlets sent out with it, being reprints of such parts of the reports for 1885 and 1890 as relate to edible fungi. They contain some very good colored plates and some serviceable information, although as contributions to science they do not rank high, and the accuracy of the statements is not always above criticism.

OPEN LETTERS.

A suggestion in terminology.

The members of the Madison Botanical Congress through their committees on the terminology of morphology and of physiology expressed a desire for some general term that should be applied to the cell which arises from the fusion of two gametes. The word zygote has come to refer only to the product of fusing isogametes, just as oösperm (in the etymologically correct use) refers to the fusion product of heterogametes. For the general term, after much research and deliberation, the compound *syngamete* is offered. The derivation is apparent, and by preserving the word gamete as an integral part of the term, there is little difficulty in respect to comprehensibility. Some such word seems better than one in which the idea of fusion alone should be expressed, for such a word would find proper use in the morphology and physiology of Mycetozoa. But in these it is very doubtful indeed whether the fusing *plasmodiogens* are gametic in their nature. The term is herewith offered for criticism.—CONWAY MAC MILLAN, *University of Minnesota, Minneapolis.*

Introduced plants in the arid region.

I forward the inclosed list to show that though we dwell in the arid region we can show a very fair assortment of introduced plants and shrubs.

The list is made out from what grows on my two lots 100 by 300 feet in our village. The lots are bisected by a small river, the Vasquez Fork of the Platte, and is blessed with abundant moisture in part.

We are in latitude 39° 45' 24'' north with an altitude of 5,660 feet above the sea. Our yearly rain-fall and melted snow varies from thirteen and one-half to eighteen inches.

Stachys and Deutzia are from Japan, and present no trouble in naturalization, if I permit them to extend.

Sonchus is a late visitor. This plant and Taraxacum threaten to ingulf all the rest, and to supersede Atriplex and Amarantus even in the richest soil. A portion of the two lots I never irrigate. Here the native plants resist all encroachment from introduced species.—E. L. BERTHOUD, *Golden, Colorado.*

[The accompanying list gives the names of sixty-five genera (species not named) of introduced plants. Of these six are indicated as having two species each introduced and one with three species. In addition there are seven of whose introduction there is some doubt.—EDS.]

NOTES AND NEWS.

DR. KARL VON DALLA TORRE has been called to the professorship of botany in the University of Innsbruck.

DR. H. MŒLLER, heretofore *privat-docent* in botany in the philosophical faculty of the University of Greifswald, has been called to a professorship.

THE FLORA of St. Vincent (W. Indies) is catalogued in a recent *Kew Bulletin* (Sept.). In this flora the Leguminosæ largely predominate, with the Gramineæ, Rubiaceæ, Compositæ, and Orchidaceæ following at a wide interval.

THE KEW *Bulletin of Miscellaneous Information* is being made more and more valuable to systematists. The July number contains the fifth decade of new plants cultivated at Kew, and the sixth decade of new orchids. The department of Miscellaneous Notes is also to be commended for the current information it contains.

THE SEVENTH annual report of the Botanist of the Nebraska State Board of Agriculture is chiefly made up of a preliminary description of the native and introduced grasses of the state, aided by numerous cuts in the text. The species number 154, and a call for the aid of observers throughout the state is made by Dr. Bessey.

THE ARNOLD ARBORETUM is the subject of very high praise from George Nicholson, Curator of the Kew Gardens, who recently visited it. His impressions concerning it appear in the *N. Y. Tribune* (Sept. 10th) and are copied in *Gardener's Chronicle* (Oct 7th). It is certainly true that this splended institution is too little known and appreciated in its own country.

DR. FRIEDRICH TRANGATT KUETZING, the distinguished algologist, died at his home in Nordhausen, Saxony, on the ninth of September in the eighty-seventh year of his age. He was born at Ritteburg in Thuringia, December 8, 1807, studied at Halle, was made professor of natural science in the Realschule at Nordhausen in 1835, and still retained the position at the time of his death.

UNDER THE LAW of homonyms, Professor E. L. Greene, in *Erythea* (October), proposes the name *Forsellesia* for *Glossopetalon* Gray, (1853), not Schreber (1789), and *Bourdonia* for *Keerlia* Gray (1852), not DC.

(1836), both of *Plantæ Wrightianæ.* Forselles was a Swedish mining engineer and botanical writer of half a century ago, and Bourdon a Parisian botanist in the earlier part of this century.

LIGNIER STATES[1] that a very concentrated alcoholic solution of vesuvin can be used to show up to advantage the lignified parts of silicified (fossil) plants. Sections cleaned in chloroform are placed for twenty-four hours in the solution, washed in absolute alcohol and mounted in balsam.

JENSEN finds[2] that Euglena viridis and Chlamydomonas pulvisculus show distinct geotropism, though usually the geotactic movements are overpowered by the directive influence of light, heat and chemical agents. Upon his experiments he bases a theory of geotropism of which the keynote is the differences of hydrostatic pressure in different sections of the organism.

THE FIRST half of an extensive contribution to the literature on the pollination of flowers will be found in the Botanisch Jaarboek[1] v (1893). 156-452. The work is by Dr. J. MacLeod and is illustrated by many excellent figures in the text. After the admirable pattern of Müller he gives an account of the relations between insects and flowers in a part of Flanders. The second installment will follow in volume six of the Jaarboek.

MR. ARTHUR BENNETT, in his notes on Potamogeton in *Journal of Botany* (October), considers two American species, *P. Spirillus* Tuck. and *P. fluitans* Roth. The former he considers to be *P. dimorphum* Raf., and under the latter considers the vexed question of its relation to *P. lonchites* Tuck., finally proposing to consider them distinct, the *P. fluitans* Roth not occurring in North America, and *P. lonchites* being a synonym of *P. Americanus* Chamisso.

THE MORPHOLOGY of the root tubercles of Leguminosæ is discussed by Dr. Albert Schneider, in the *American Naturalist* for September. The work was done in the University of Minnesota, and the general conclusions reached are that the tubercles are developed exogenously from a meristem area surrounding the infected region, have a well developed vascular system differing from that of the root, and anatomically resemble a stem more closely than a root.

IN 1889 the genera of Musaceæ (Banana Family) were presented by Petersen in Engler and Prantl's "Die natürlichen Pflanzenfamilien", and now, in the *Annals of Botany* (VII. 189-222), Mr. J. G. Baker publishes a complete synopsis of the same family. The true bananas (Musa) are naturally the most perplexing, Petersen estimating that there are about 200 cultivation forms, reducible to about twenty species. Baker presents them in thirty-two species, four of which are new.

IN A MEMOIR on the anatomy of the cell in fungi and filamentous algæ, W. Wahrlich shows that protoplasmic continuity exists very

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[1] Bull. Soc. Linn. Norm. IV. VI (1892). 9.—Bot. Cent. LVI (1893). 18.
[2] Pflüger's Archiv f. ges. Physiol. LIII (1893). 428.—Bot. Cent. LVI (1893). 20.
[1] Issued by Dodonæa; publisher: J. Vuylsteke, Koestraat 15, Ghent, Belgium.

generally in the fungi, a strand passing through a simple central pore. He contests emphatically the presence of plasmic threads in the algæ, in opposition to Kohl. As to the division of the cells of algæ he repudiates the common thèory of the origin of the transverse wall as an annular thickening and revives the old "box" theory, holding it to be formed as a true annular fold, following the contour of the shrinking protoplasm.

STAHL'S well known researches on the protective function of oxalic acid have been confirmed by a study of the distribution of oxalic acid and acid oxalates by Rudolf Giessler.[a] He finds them chiefly in the epidermis and peripheral tissues; in much smaller quantities, if present at all, in deeper tissues; generally wanting in underground parts. Tannin seems to serve as a protection when oxalic acid is wanting. His anatomical studies are complemented by experiments with snails and plant lice.

THE *Bulletin of the Torrey Botanical Club* for September contains the following papers read before the botanical section at the Madison meeting: *Williams* on Lichens of the Black Hills and their distribution; *Atkinson* on Symbiosis in the roots of the Ophioglossaceæ, and Photography as an instrument for recording the microscopic characters of micro-organisms in artificial cultures; and *Pammel* on Crossing of Cucurbits, a paper read by title, still further testifying by experiments to the fallacy of the popular belief that cucurbits hybridize.

IT SEEMS that the name *Halesia*, as applied to the "silver-bell trees" of the south and dedicated to the distinguished Stephen Hales, must disappear. In *Garden and Forest* (Oct. 18th) Dr. N. L. Britton points out that it is a homonym, the earlier *Halesia* of P. Browne being a West Indian tree, now *Guettarda* L. Under the circumstances the genus is very appropriately dedicated to Dr. Charles Mohr of Mobile, whose name should surely be connected with the southern forest trees. The three species, therefore, stand as *Mohria Carolina* (Halesia tetraptera), *M. diptera* and *M. parviflora*.

THE REINHOLD-GILTAY microtome, a machine of rather complex construction, but adapted to the finest work, is described by Dr. J. W. Moll in the *Zeits. f. wiss. Mikros.* IX (1892). 445–465. In the same paper he describes investigations on the tearing and compression of sections in cutting and the preparation of the knife to avoid these difficulties. He also sought out three polishing powders which give a proper edge for the best results. The first is iron oxide prepared by precipitating iron oxalate from solutions of ammonium oxalate and iron sulphate, drying, glowing, and rubbing up to a fine red-brown powder, (which, however, loses its sharpening power when it becomes red). The second is prepared by heating Mohr's salt in a Hessian crucible in a furnace until no vapor is given off, rubbing up the mass in water, washing and drying. The third is a polishing powder of unknown composition obtained under the name of "Diamantine no. 1." All three are used after polishing the knife edge with Vienna chalk. A piece of plate glass gives the best surface on which to use all such powders.

[a] Jenaische Zeits. f. Naturwiss. XXVII (1893). 344.—Bot. Cent. LVI (1893). 35

BOTANICAL GAZETTE

DECEMBER, 1893.

The bacterial flora of the Atlantic ocean in the vicinity of Woods Holl, Mass.

A contribution to the morphology and physiology of marine bacteria.

H. L. RUSSELL.

WITH PLATE XXXVI.

(Concluded from p. 417.)

Description of new forms.

While some of the forms that have been isolated at Woods Holl have been identified with those found in Mediterranean waters, the predominant species have in most cases specific differences that separate them from the European species. A careful search in the systematic works of Eisenberg, Frankland, Lustig, and others that describe mainly the water forms failed to give any evidence that the forms here dealt with had been previously recorded. This is not at all surprising when we take into consideration the fact that the systematic part of bacteriology has heretofore concerned itself mainly with the fresh water types and that little or no attention has been given the marine bacterial flora.

I have, therefore, described the predominating species that have been isolated and studied during the past season in order that we may have a basis for comparison with European marine forms.

The difficulties of a satisfactory classification of bacterial species have not as yet been entirely overcome, but the present tendency to introduce physiological and ecological characters in the description of new forms is virtually a necessity. The correlation of form and function in the living organism is so close that both factors must be considered in

any accurate and thorough description that will enable a later student to positively identify the species.

The bacterial flora of any particular habitat may be considered in two ways—qualitatively or quantitatively. Often there is a wide diversity as to the number of different forms that are present in any particular location, but as a rule the majority of individual organisms belong within the limits of comparatively few species. This is more especially true with reference to a region in which the adventive or introduced forms are comparatively few, and with the great bulk of oceanic waters these conditions prevail. Where they receive the drainage of large river systems or are subject to sewage contamination of large cities, the number of species as well as the number of individual germs is usually increased, but these conditions do not obtain with reference to the locality investigated this season.

The location of Woods Holl is so favorable with respect to the possibility of the introduction of adventive forms that it seems highly probable that the conditions here are quite normal and may fairly represent the condition of marine bacterial life in general.

While the water and mud masses of this region possess bacterial life in considerable abundance, no great variety of species is to be noted. The four or five forms that will be described in detail comprise by far the larger proportion of living germs that are to be found. In numerous instances, the cultures contained not more than two or three species, and very rarely did any single culture show more than four or five different forms.

This peculiarity is quite noteworthy, as the number of predominating species of any particular habitat is rarely so small as in this case.

Bacillus limicola, sp. nov.—This species is the most characteristic indigenous inhabitant of the ocean bottom in the Atlantic near Woods Holl. Almost every test that was made from the mud revealed the presence of this bacillus.

In regard to its morphological characters, it is a bacillus, but it has a variability of form and size that is quite remarkable. If a cover glass preparation be made from a rapidly developing agar culture, such wide diversity of forms present themselves, that one can scarcely avoid the conclusion that the culture has become contaminated, even though he may

be satisfied as to the purity of its origin. There are bunches of short oval forms, almost spherical, that closely resemble large micrococci (fig. 1, *B*, *a*), others of an elongated normal bacillus type, often united in short filaments (fig. 1, *B*, *c*), while still others are curved after the manner of a spirillum.

The variability of form is also accompanied by a wide range in size, not only among the different growth forms but among those of the same morphological structure. Besides what seems to be the typical, elongated bacillus, there are often seen individual cells, having one end pointed, or lance-shaped (fig. 1, *B*, *b*). These cells are usually united in pairs, the larger ends being in contact and present a strong resemblance to the lanceolated forms found in Bac. pneumoniæ. The range in size of the bacillus type of this germ varies within the limits of $0.7-1.8\mu$ in width, while the length is sometimes no more than 1μ and from that to 5μ. The short spheroidal cells are as a rule somewhat wider than the bacillus type, and have a more refringent aspect that closely recalls the appearance of arthrospores of some species, but the cell union of these forms would hardly be conceivable with true spores.

Then, too, the fact that old non-sporogenous cultures, having these refringent cells, were killed at the comparatively low temperature of 55°C. is against the view that they are genuine spore stages of this bacillus.

Whether the wide variation in form and size is due to the pleomorphic nature of the species or to involution changes is a question. These appearances are to be noted in cultures 24^{hrs} old and in hanging drop preparations the unstained bacteria have the ordinary optical properties of active protoplasm, but when subjected to staining agents like methylene blue or carbol-fuchsin, they stain so irregularly as to lead one to believe that a degeneration of the protoplasm has already begun. Cover-glass preparations stained by Gram's method are not decolorized.

When the germ was first isolated at Woods Holl, spores were often observed in agar cultures kept at ordinary summer heat, but in later cultivations on both salt and fresh water media, I have been unable to demonstrate them either at room temperature or blood heat. This peculiarity is somewhat remarkable, yet the observance of this phenomenon with other bacterial forms like anthrax when cultivated on

artificial media for considerable time shows that this condition is not exceptional. It is another instance that goes to show how intimate the relation is between the organism and its environment; how that by modification of exterior surroundings, such a deep seated phenomenon as that of reproduction may be profoundly affected.

The chromogenic function of this bacillus is best seen when grown on an agar medium. On this substratum, it presents a fairly copious growth, smooth and shining. At first the color is but slightly developed, but as the culture increases in age, it passes from an ochreous yellow to a deep rich orange. There is considerable variation in the production of the pigment depending upon the temperature at which the culture is grown. Cultures kept at blood heat remain very pale and do not develop, even in old age, the rich orange tint that is seen in growths kept at the temperature of the room.

In gelatin the growth characters are as follows: In tube cultures 24 hours old, there is a slight pit observable at surface point of inoculation caused by the liquefaction of the gelatin. This spreads superficially, and also gradually deepens until there is a broad liquefied funnel formed in the gelatin that slowly widens until the sides of the tube are reached. Usually there persists for several days at the surface, an air pit in the medium, caused by the evaporation of liquefied material. The consistency of this liquid mass is thick but not viscous. The fluid gelatin is filled with a slightly flocculent precipitate that remains in suspension, while a considerable amount of amorphous yellowish growth material is deposited on bottom. No membrane is formed on the surface of the fluid.

The appearance of colonies in gelatin plates is not especially characteristic. The germs quickly liquefy the medium in a regular circular form. Macroscopically, the edge of the colony is translucent while opaque patches of zooglœa cover the center. These are usually of a dull, grey color, but are sometimes tinged with a faint reddish lustre when observed in reflected light. Under the lens, the edge of the colony is granular, the extreme periphery being the densest. Short irregular filaments radiate from the extreme edge into the surrounding gelatin.

On agar, the germ develops quite rapidly although not very luxuriantly. The culture appears on the second day as a

smooth, shining colony that spreads out in a thin layer over surface of medium.

The young cultures are often tinged with yellow, but this gradually deepens with age until it reaches a rich orange brown.

On potato, no growth could be obtained, while in milk, the casein was entirely peptonized although but a slight amount of acid was produced. The milk serum remains turbid. Under anaerobic culture conditions, no growth could be noted.

Bacillus pelagicus, sp. nov.—One of the most common and widely distributed of the marine bacteria that have been observed in this locality is a small, short bacillus that has been named B. pelagicus.

This species was found abundantly in both water and mud, and in almost every culture that was made. The mud layers were filled with it, both in a vegetative and a spore condition, so that it is evident that its presence on the sea bottom is not to be accounted for by simple deposition of the spores from the water masses above. It is found abundantly in the vicinity of the shore, as well as in the samples that were taken by the *Grampus* 100 miles from land.

Morphologically, it is a slender bacillus, usually quite short ($0.4\mu \times 1.5$–2.5μ), but a number of segments may be united into filaments of various lengths. In vigorous cultures, the shorter forms have a very lively, tumbling movement. Small, narrow spores are easily formed on different media at ordinary temperatures. This bacillus takes aniline stains easily. When Gram's solution is used, the bacilli show a spotted appearance, the granules retaining the stain while the remainder of the cell is decolorized.

In cultures it grows fairly well, although not luxuriantly. In gelatin plate cultures growth is not rapid, but the food-medium is gradually liquefied, the grayish white growth masses settling to the bottom of the colony. Under the microscope, the colony presents the usual granular appearance, the edge of it being sharply defined. In gelatin tubes, the appearance of the cultures is more characteristic. It spreads superficially more rapidly than in vertical direction, forming a shallow cup filled with homogeneously granular, turbid, liquefied gelatin that is covered with a copious white film on surface.

The predilection for oxygen is further shown when cultures are made under anaerobic conditions. In deep gelatin tubes

and in cultures prepared according to Buchner's pyrogallic method, it does not develop.

The liquefaction of the gelatin in ordinary tube cultures progresses slowly until the side of the tube is reached and then continues steadily to the bottom in horizontal layers. In old cultures, the film on the surface often has a reddish hue. The appearance along submerged portions of the needle track indicates only a scant growth.

Streak cultures on agar show a thin hazy film becoming more opaque in lower part of tube where condensation water collects. On agar plate cultures, considerable variation is to be noted. Sometimes the colonies are small and opaque, then again they are often spread out in a thin film as in tubes. The colonies on agar are more or less viscid, and adhere easily to the needle when touched.

On potato, this bacillus is a chromogene and grows more luxuriantly on this than any other medium. In thirty-six hours, at room temperature, the culture growth is apparent where it appears as a glistening yellowish drop around inoculation puncture.

This rapidly spreads until the whole surface of potato is often covered with a deep orange-yellow growth that changes later in old cultures to a brick red.

Milk is modified profoundly, the casein being coagulated by the production of acids. This coagulated material is soon peptonized, the serum remaining more or less cloudy.

Bacillus litorosus, sp. nov.—This form was found in both water and mud layers in not inconsiderable numbers, although not nearly so common as B. pelagicus.

Morphologically, it belongs to the larger type of bacteria, being a slender, typical bacillus form ($1\mu \times 4\text{–}7\mu$). It is usually found as an isolated individual or closely united in short chains of two or four segments. The protoplasm of the cells is usually homogeneous. This form is motile and is characterized by a slow, stately movement of a serpentine nature.

In ordinary gelatin media, it forms quite a characteristic culture. Two or three days after inoculation, liquefaction of gelatin is to be noted at the surface and along needle track as well. The peptonizing of this substance takes place more rapidly at surface, so a broad funnel shaped sac is formed as a result of two or three days' growth. There is usually

a sharply defined air pit at the surface, the base of which is covered with grayish masses of zooglœa. In the lower part of the liquefied needle track, spirally twisted strands are to be noted. A thick membrane is finally formed on surface from bits of flocculent zooglœa that adhere in masses which easily rupture upon the slightest movement. In old cultures, the bottom of the liquefied gelatin is covered with flocculent growth masses and the culture is not especially characteristic.

On agar, this bacillus grows rapidly, forming a thick dull white colony with a sharply defined border. Under the lens, the edge of the colony is seen to be formed of numerous parallel filamentous bands, that are looped at the edge so there are no freely projecting filaments radiating into the surrounding medium.

In agar tubes, these well defined grayish patches become confluent and more luxuriant in the lower part of the tube. At room temperature, the germ thrives better than at blood heat. In deep stick gelatin or agar cultures as in bouillon tubes prepared according to Buchner's pyrogallic acid method, a marked growth is to be noted, showing the facultative nature of the germ.

On potato there is a well defined compact white growth that is soft in texture and easily detached. When inoculated into milk, this bacillus sets up a very rapid change coagulating the casein and finally peptonizing it. The serum of the milk is at first filled with a cloudy precipitate that is formed from the masses of zoogloea but these are finally deposited on the coagulated casein.

Bacillus maritimus, sp. nov.—Bacillus maritimus is found quite plentifully distributed in the mud layers. It is a sporogenous bacillus of good size (dimensions $1.50\mu \times 3.5$–6μ) with round ends, but the cells are usually quite closely united into filaments of varying length. The protoplasm has often a granular appearance so characteristic of marine bacterial forms. The spores are small, scarcely exceeding one-half the width of the cell ($0.7\mu \times 1.5\mu$). These are readily formed in forty-eight hours at the room temperature.

On artificial media this germ grows luxuriantly. It is seemingly indifferent to the salt content of the substratum upon which it develops. In gelatin, two days growth is marked as follows: a very shallow pit spreads out over surface, the bottom of which is covered with a grayish growth that

has the peculiar luster so characteristic of the freshly broken surface of limestone. From the base of this shallow depression fine filaments radiate for a short distance into the gelatin. Growth along needle track is barely visible, thus showing the aerobic nature of this germ. In three days, this superficial growth spreads slowly to the sides of the tube and the gelatin is slowly peptonized in horizontal layers, the liquefied material being filled with cloudy masses. An imperfect film that is easily ruptured is often to be observed on surface of culture.

On agar, growth is copious but not especially characteristic. The surface of the medium is covered with a dense white covering smooth in character.

On potato it also thrives luxuriantly as a thick grayish white coating covering nearly whole surface of potato. Surface of growth is dull and mealy in texture.

Conclusions.

It may be well to summarize briefly the results that have been reached in the foregoing pages in the following general conclusions:

1. Bacteria are present in the oceanic waters, both of the high seas and in litoral regions, although they are not so abundant as they are in fresh water masses.

2. While the bacterial flora of the sea bottom in the region investigated this year is not near so great, from a numerical standpoint, as that in the neighborhood of Naples, yet the accuracy of the general conclusions drawn from the Mediterranean work in regard to the slime bacteria is strengthened by the present season's work.

Bacteria exist in the mud of the ocean bottom in large numbers, and their presence there is not due merely to the effect of gravity but to the growth and reproduction of indigenous slime species. Forms that are prevalent in the water masses above are also found in the mud layers in a vegetating as well as in a latent stage of development.

3. Disregarding the influence of introduced forms from the land, which is in this case very slight, the indigenous marine flora of both water and sea floor is largely comprised within the limits of relatively few species.

These may often be distributed over more than localized areas, and in some instances come to be cosmopolitan in their

range. Not only is their geographical distrit tensive but the vertical range of the various that of the majority of the higher forms of lil

4. While no pathogenic property was note forms isolated, other physiological character tion of soluble enzymes and the ability to red were conspicuous characteristics of the more

University of Wisconsin.

Explanation of Plate XXXVI.—Figures of bacteria ii a Zeiss microscope, tube length 160mm, no. 6 compensatin ogeneous oil immersion.

Fig. 1. *A. Bacillus limicola*, gelatin culture 5 days olc

Fig. 1. *B. a*, Short type of cells from agar culture; *b*, old agar culture; *c*, normal bacillus type from agar culture

Fig. 2. *A. Bacillus pelagicus*, culture in gelatin.

Fig. 2. *B*. Spore bearing bacilli from gelatin culture,

Fig. 3. *A. Bacillus maritimus*, gelatin culture, 2 days

Fig. 3. *B*. Single cells from potato culture, 2 days old.

Fig. 4. *A. Bacillus litorosus*, 3 days growth in gelatin.

Fig. 4. *B*. Cells from young gelatin culture.

Studies in the biology of the Uredi

Notes on germination.

M. A. CARLETON.

WITH PLATES XXXVII-XXXIX.

Within the last eighteen months I have mad dred cultures of uredineal spores, in various r seasons, in order (1) to determine as many facts cerning their biology on the one hand, and on by observing the various effects of different their germination, (2) to obtain a working b paration of fungicides for the prevention o certain economic species. A great part of t ularly that of most economic importance, has ported.[1] What I shall present here, are some gestions of a more technical nature.

Nearly all the cultures made were of the or ture style, prepared by depending a drop c medium, in which the spores were immersed surface of a cover-glass placed over an orc

[1] **Kansas Agric. Exp. Sta. Bull. *38*. Mar. 1893.**

made by glueing a glass ring to a slide. The bottom of the cell had previously been moistened with water, so that a miniature damp chamber was thus formed. In order to more certainly guard against drying, the further precaution was observed, of placing the cultures themselves in a large damp chamber. Occasionally, simple watch glass cultures were prepared, but these were seldom found to be useful, on account of their great liability to contamination.

1. Effects of different chemicals upon germination.

In carrying on the experiments in this line, one or more check cultures in water were always included in every series of cultures prepared at any one time. The results of the cultures in the various solutions were compared with those of the water cultures, and in every series where germination failed, both in water and in the other solutions, the whole experiment was discarded, of course. The uredospores of grain rusts were used in most of the experiments, particularly the uredo of *Puccinia coronata* Corda, since that species was the most abundant for the longest period in 1892, when the majority of these experiments were performed. In the following tables I give the names of those solutions only which show the most striking results, either favorable or unfavorable. The tables represent only a small proportion of the cultures actually made. The numbers in the column "strength" give the number of parts, by weight, of the commercially prepared chemicals to 10,000 parts of distilled water, in which they were dissolved. The first table shows results obtained with uredospores of *Puccinia Rubigo-vera* (DC.) Wint.:

TIME (hrs.)	MEDIUM.	STRENGTH.	RESULTS.
21	Ferrous sulphate,	10	Not very good.
21	Potassium sulphide,	10	Fairly good.
21	Copper sulphate,	10	Failure.
18	Hydrogen peroxide, (0.3 per cent. sol.),	10	Better than in water.
18	Potassium sulphide,	10	Not very good.
18	Copper sulphate,	10	Three spores germinated.
18	Copper nitrate,	10	Five spores germinated.
18	Potassium chromate,	10	Failure.
48	Atropine,	100	Failure.
48	Aloin,	100	Failure.
48	Aloin,	10	Not very good.
48	Cocaine,	100	Failure.
29	Broth of wheat leaves,		Success—long germ tubes.
29	Neutralized urine,		Only a few spores germinate—long germ tubes.
29	Non-neutralized urine,		Very few spores germinated.
29	Milk,		Success.
44	Wheat leaf broth,		Success.
44	Beef broth,		Success.

The next table shows results obtained with uredospores of *Puccinia graminis* Pers.

TIME (hrs.)	MEDIUM.	STRENGTH.	RESULTS.
7	Copper sulphate,	10	Poor, but not an entire failure.
7	Hydrogen peroxide (0. 3 per cent. sol.),	10	Good.
7	Potassium sulphide,	10	Good.
42	Hydrogen peroxide (0. 3 per cent. sol.),	10	Failure.
48	Aloin,	10	Success.
48	Chloral hydrate,	10	Failure.
48	Atropine,	10	Failure.
67	Potassium bi-chromate,	1	Not many spores germinated.
67	Salt,	10	Success,
67	Cinnamon decoction,	71.4	Very few spores germinated.
48	Camphor (commercial solution),	100	Success.
48	Tannic acid,	10	Failure: swells the germ pores.
48	Salicylic acid,	100	Failure: decolorizes the spores.
48	Morphine,	100	Failure.
48	Morphine,	10	Failure.
48	Chloroform,	10	Failure.

In the following table, including the most extensive experiments of all, are shown the results obtained with uredospores of *Puccinia coronata* Corda.

Time. (hrs.)	Medium.	Strength.	Results.
22	Potassium chromate.	10	Partial failure; a few spores germinated.
22	Copper sulphate.	10	A few spores germinated.
24	Copper nitrate.	10	Very few spores germinated.
22	Copper acetate.	100	Total failure; decolorizes, then discolorizes the spores.
22	Lead acetate.	10	Total failure.
22	Ferric chloride.	10	Failure; colors spores green.
22	Potassium permanganate.	10	Success.
23	Corrosive sublimate.	1	Failure.
23	Potassium bi-chromate.	10	Failure; contracts and shrivels spores.
24	Hydrogen peroxide (0.3 per cent. sol.).	10	Success; very free germination.
24	Potassium sulphide.	10	Success; better than in water.
27	Ammonium sulpho-cyanide.	10	Success; very free germination.
27	Chrome alum.	10	Success; very free germination.
27	Potassium chromate.	10	Three spores germinated.
24	Copper chloride	10	Failure; decolorizes spores.
24	Potassium sulphide.	10	Success.
24	Potassium sulphide.	100	Failure.
24	Lead acetate.	10	Not many spores germinated; germ tubes stunted.
24	Copper acetate.	10	Failure.
47	Sodium arsenite.	10	Success.
47	Potassium chromate.	10	A few spores germinated.
47	Copper nitrate.	10	A few spores germinated.
48	Ammonium carbonate.	10	Success; very free germination.
48	Ferric chloride.	10	Very few spores germinated.
52	Sodium thio-sulphate.	10	Success.
52	Potassium per-manganate.	10	Success; not very free germination, however.
16	Lead acetate.	10	Very few spores germinated.
16	Ammonium carbonate.	100	Success; but germination not very free.
16	Magnesium chloride.	10	Success.
16	Ammonium sulpho-cyanide	10	Success.
16	Chrome alum.	10	Fairly well.
16	Sodium thio-sulphate.	100	Success.
27	Magnesium chloride.	10	A few spores germinated.
25	Potassium chromate.	10	Failure.
25	Sodium thio-sulphate.	100	Success; but germination not very free.
25	Nitric acid.	68	Failure.
25	Nitric acid.	6.8	Success; very free germination.
25	Corrosive sublimate.	1	Failure; decolorizes spores.
25	Potassium sulphide.	10	Success.
25	Acetic acid.	10.8	Failure.
25	Acetic acid.	0.54	Success.
18	Sulphuric acid.	10	Failure; decolorizes spores.
18	Potassium cyanide.	1	Success; very free germination.
52	Potassium cyanide.	10	Failure.

TIME. (hrs.)	MEDIUM.	STRENGTH.	RESULTS.
19	Potassium bi-chromate.	1	Fairly well.
24	Potassium sulphocyanide.	10	Five spores germinated.
26	Copper acetate.	1	A few spores germinated.
26	Copper sulphate.	1	Very few spores germinated.
26	Corrosive sublimate.	0.1	A few spores germinated.
26	Potassium bi-chromate.	1	Success, but not very free: swells out germ pores.
26	Copper nitrate.	1	Failure.
26	Lead acetate.	1	Six spores germinated.
21	Copper sulphate.	1	Success.
21	Potassium chromate.	10	Success.

Germinations of other species were not sufficiently extensive to justify tabulation. *Æcidium Fraxini* Schw. failed to germinate in copper sulphate (1:1,000) in twenty-six hours, and in potassium bi-chromate (1:1,000) same time, but germinated successfully in the latter solution with a strength of 1:100,000, producing peculiar short bulb-like germ tubes, for illustration of which, see pl. XXXVII, fig. 6. Quite a number of summer spore-forms, including various aecidia and uredines, germinated more or less freely in weak solutions (five to ten per cent.) of sugar and honey. In only one instance have I been able to grow the spermatia. The spermatia of *Uredo Cæoma-nitens* Schwein. budded sparingly, on May 31, 1893, after twenty-four hours in a dilute solution of honey, but would not germinate in water. This is in confirmation of the results obtained by Cornu[2] and Plowright.[3]

A careful comparison of the results above given, justifies certain conclusions of interest and importance. (1) Compounds containing mercury, copper, iron, lead and chromium (where these elements are in sufficient proportions), and strong acids, are *inimical* to the growth of Uredineæ. (2) Compounds containing oxygen, sodium, potassium, magnesium, sulphur and probably carbon and ammonium, in great proportions, are *favorable* to the growth of Uredineæ. (3) Alkaloids are injurious to the growth of Uredineæ. The compound radical cyanogen, might properly come under group (1), for, although the sulpho-cyanides of ammonium and potassium are not unfavorable, such fact may be explained by

[2]Bull. de la Soc. de Bot. de France XXIII (1876). 120–121.
[3]British Uredineæ and Ustilagineæ, 14–16.

the presence of the favorable element sulphur, not present in potassium cyanide. Again, while bi-chromate of potassium is extremely injurious, chrome alum is rather favorable, which may be explained by the fact of there being such a small proportion of chromium in the latter compound, compared with its amount in the former. The effect of the element nitrogen is hardly determined by these experiments, but the majority of the facts seem to point to its being injurious, since its presence in alkaloids makes the only difference, as far as mere composition is concerned, between these compounds, which are injurious, and the carbohydrates which are favorable; and since it is the greater constituent, by weight, in the unfavorable radical, cyanogen. The correctness of this idea would tend to overthrow the opinion, often expressed, that an excess of nitrogenous compounds in soils is favorable to the growth of rust. Another conclusion to be derived from the results of these experiments, is (4) that potassium sulphide and sodium hyposulphite, common fungicides, are likely to be entirely useless for the prevention of rusts, since the spores grow readily in solutions of these compounds, even with the latter in a solution of 1:100.

Dr. E. Wüthrich,[4] the only one, as far as I know, who has experimented in this same line, has had results very similar to my own, in so far as he has reported them. In his experiments with uredospores of *Puccinia graminis* Pers., germination took place in a solution of potassium nitrate of fifty per cent. strength. I did not use this salt at all, but it will be noted that it contains the favorable element, potassium, that I have already mentioned. On the other hand, he has not reported the employment of potassium bi-chromate, one of the salts having the most injurious effect upon germination in my own experiments. But where we have used the same compounds, the results have been practically the same.

2. Vitality and vigor of the summer spore-forms.

Uredospores and æcidiospores have much greater powers of endurance than have usually been ascribed to them. Wüthrich, in his article above cited, makes the following statement with respect to the resistance of uredospores of *Puccinia gra-*

[4]Ueber die Einwirkung von Metallsalzen und Säuren auf die Keimfähigkeit der Sporen einiger der verbreitesten parasitischen Pilze unserer Kulturpflanzen. Zeits. f. Pflanzenkrankheiten II (1892). 84–86.

minis to the action of various solutions in their germination, compared with spores of other fungi, with which he also experimented: "The spores of various fungi show unlike powers of resistance against solutions of metal-salts and acids. The conidia of *Peronospora viticola* prove to be the most susceptible of the forms investigated. Then, following these, in the order of decreasing sensibility, are the conidia of *Phytophthora infestans*, æcidiospores of *Puccinia graminis*, conidia of *Claviceps purpurea*, spores of *Ustilago Carbo*, and uredospores of *Puccinia graminis*."[5] According to this statement, uredospores have, comparatively, great powers of resistance to various solutions, and there is the further fact that æcidiospores are much less resistant than uredospores, both of which facts are further established by my experiments, so far as I have gone.

They are also similarly resistant to extremes of cold. It was already well known that the mycelium of *Puccinia Rubigo-vera* can pass the winter without injury, in the tissues of its host.[6] Experiments at this station have further proved that even the *uredospores* are preserved during the winter months, and may be taken from the field in *any month* of the year and easily germinated.[7]

A plant of *Carex* (*vulpinoidea?*) bearing both uredospores and teleutospores of *Puccinia Caricis* (Schum.) Rebent. was transplanted to the green-house from out doors in December, 1892, and uredospores, taken from this plant in January following, readily germinated, producing germ tubes of rather peculiar form—wide, and often branching (pl. XXXVIII, fig. 11). Germination would probably have taken place at the time of transplanting, but was not attempted. *Æcidium tuberculatum* Ell. & Kell. is still producing æcidiospores on *Callirrhoe involucrata*, out doors, here at Manhattan, at the time of this writing (October 15th), and Mr. E. Bartholomew, of Rooks co., Kan., tells me that he has seen in December æcidiospores on specimens of this host growing close by a large snowdrift. In the spring, æcidiospores of this species begin forming about the first day of April. Æcidiospores of *Æcidium Pentstemonis* Schwein., and uredospores of *Uromy-*

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[5] l. c. translated from p. 93.

[6] See Sorauer, Handbuch der Pflanzenkrankheiten, ed. 2. II. 216; and Bolley, Bull. Agric. Exp. Sta. Ind. *26*, 13 and 19.

[7] See Bull. Kan. Agr. Exp. Sta. *38*, 11, for full discussion of this matter.

ces Zygadeni Pk. and *Puccinia Hieracei* (Schum.) Mart. begin forming also about April 1st.

It is not always necessary that the summer spore-forms should be fresh in order to germinate readily, although fresh spores usually germinate best. Spores of *Æcidium pustulatum* Curt. and *Uredo Cæoma-nitens* Schwein. collected at Lawrence, Kan., May 19, 1892, and placed in drop cultures at this station the next day, germinated freely in 31 hours, producing vigorous germ tubes. I have often germinated uredospores, after they had lain in the collecting can one or even two days. Prof. B. T. Galloway,[8] several years ago called attention to the great scarcity of ash rust, *Æcidium Fraxini* Schwein., in 1888, and to the fact that various attempts, by the Division of Vegetable Pathology, to germinate it in different media, were only partially successful at that time. At the same time he suggested the question whether the rust might not germinate more readily in seasons of great abundance. As bearing upon this question, it may be of interest to say that in the summer of 1892 the rust was extremely abundant here, particularly on young trees, attacking the twigs as well as the leaves and sometimes entirely destroying large portions of the branches for a distance of two feet or more. At the same time, the spores were easily and repeatedly germinated in ordinary watch glass cultures, although it had been difficult for me to germinate them at other times. I think I have observed the same fact with respect to other species.

As to the length and rapidity of growth of germ tubes, there is great variation among the different species. Those of the uredospores of *Puccinia Rubigo-vera* represent about the average length, so far as my observations have extended. Those of *Puccinia Hieracei* are a little longer than the average. (See pl. XXXVIII, fig. 14.) Those of *Puccinia graminis*, and of various rusts on grasses, are much longer. The one figured in pl. XXXVIII, fig. 12, has a length of 1.075^{mm}, and is but little, if any, longer than the average for that particular culture, of seventy-two hours. Uredospores of *Puccinia Sorghi* Schwein. sometimes show no indication of germination during the first day, but finally, at the end of forty-eight hours, produce germ tubes of very fair length. Other species seem to produce their entire growth in twenty-four

[8] Journ. Mycol. v (1889). 95.

hours. Germination in the same species will vary greatly, according to the conditions. Fig. 8, pl. XXXVII, shows the progress that various spores have made at the end of four hours. On January 25, 1892, uredospores of *Puccinia Rubigo-vera*, taken from outdoor plants, germinated in *two hours* in warm water, producing germ tubes 50μ long. In this case germination could actually be seen going on. The germ pores began swelling almost immediately on being placed in the water.

3. A new method of producing sporidiola.

In the course of my experiments with the germination of teleutospores, I have observed a new process in the formation of sporidiola[9] not hitherto mentioned so far as I know.[10]

In the ordinary process it is well known that the sporidiola are stalked, or attached to pedicels of peculiar shapes—usually very much narrowed at the point of attachment. These are well illustrated in pl. XXXVIII, fig. 15 and pl. XXXIX, fig. 16. The pedicels may arise from various points for some distance along the promycelium, or they may be almost in clusters, originating from points rather close together. The process that I shall describe is very different, and is as follows: At first the promycelium presents the ordinary appearance, but presently there is an evident disposition in the terminal portion to separate into well-marked divisions. The protoplasm concentrates in these divisions; constrictions form between them; the divisions, at first much longer in the direction of the promycelium, become shorter and wider, then rounded, and finally, separate from the remaining portion of the promycelium, as free spherical bodies, by the ordinary process of acrogenous abjunction. A half dozen or more may be produced in succession from the same promycelium. Of course those nearest the end are the oldest, and may be in the process of separation while those farthest back are just beginning to form.

We have in this process a production of *catenulate* sporidiola, in contradistinction to the *pedicelled* sporidiola hitherto observed. I have observed this process in three species, *Puccinia Grindeliæ* Pk., *P. variolans* Hark. (so-called) on *Aplo-*

[9] I use this term, in preference to "sporidia," in order to avoid confusion with the sporidia of ascomycetes and other groups. It is suggested by Saccardo, in "Rathschläge für die Phytographen insbesondere die Kryptogamisten;" Hedwigia XXX. (1891). 56–59, and used by De Toni in Sacc. Syll. VII. 528.

[10] Lagerheim *possibly* refers to it (Jour. Mycol. VII. 46–47), but he observed only LEPTO-UREDINEÆ, in which I no not find this process.

pappus spinulosus, and in the mesospores of *P. Sporoboli* Arth. This process of germination may prove to be of importance in classification, and help to clear up the existing confusion regarding some of our western so-called LEPTO-PUCCINIÆ on composites. I am not yet prepared, nor have I the space in this article, to make any statements, on this basis, concerning the systematic position of such species.

In two other cases, those of *Puccinia Malvastri* Pk. and the *Puccinia* of *Lygodesmia juncea*, the indications were that catenulate sporidiola would be formed, but germination ceased before reaching that stage. The germination of *Puccinia Sporoboli* was the most remarkable. In this case, not a *single two-celled* spore germinated while the *mesospores* germinated profusely, uniformly producing catenulate sporidiola.

All these species, except *Puccinia Sporoboli*, were collected in October, 1892, and germinated after being kept in paper pockets till April, 1893. It may be said that this fact may have had something to do with the peculiar germination of these species, and possibly it did, but *Puccinia Phragmitis* (Schum.) Körn. and *Puccinia Redfieldiæ* Tracy were collected at the same time, and after passing through the same treatment, germinated in April, also, but with the production of the ordinary pedicelled sporidiola; besides, *Puccinia Sporoboli* was taken from fresh out-door material.

I have constantly had much aid from Prof. A. S. Hitchcock, in the course of my investigations, particularly in the selection and preparation of the various solutions used in germination.

Kansas Experiment Station, Manhattan.

EXPLANATION OF PLATES XXXVII—XXXIX.

Fig. 1. Germination of uredospores of *Puccinia coronata* Corda, in ammonium carbonate (1:1000), after 48 hrs. × 247.

Fig. 2. Condition of the same, in potassium bi-chromate (1:1000), after 23 hrs. × 333. Spores much contracted and shrivelled.

Fig. 3. Germination of uredospores of *Puccinia Rubigo-vera* (DC.) Wint. in sodium chloride (1:1000), after 21 hrs. × 247.

Fig. 4. Germination of uredospores of *Puccinia coronata*, in sodium thiosulphate (1:1000), after 52 hrs. × 333. Germination vigorous.

Fig. 5. Germination of *Æcidium Fraxini* Schwein., in watch-glass water culture, after 3 days, June 15, 1892. × 333.

Fig. 6. Germination of the same, in potassium bi-chromate (1:100,000), after 28 hrs. × 333.

Fig. 7. Condition of uredospores of *Puccinia coronata* in lead acetate (1:1000), after 22 hrs. × 333.

Fig. 8. Germination of uredospores of *Puccinia Rubigo-vera*, in water, after 4 hrs. × 200. Shows the various stages in germination.

Fig. 9. Germination of the same, in water, after 44 hrs. Jan. 21, 1893. × 200. Spores taken from volunteer wheat, out doors.

Fig. 10. Spores taken from dead leaves of volunteer wheat, out doors, Feb. 25, 1893. Seem to have germinated on the wheat, and further growth checked by the cold. × 247.

Fig. 11. Germination of uredospores of *Puccinia Caricis* (Schum.). Rebent. in neutralized urine, after 50 hrs. Jan. 1893, × 333. Spores from green-house plant, transplanted from out doors Dec. 1892.

Fig. 12. Germination of uredospores of *Puccinia graminis* Pers. in water, after 72 hrs. Germ tube measures 1.075^{mm}. × 247.

Fig. 13. Germination of *Uredo Cæoma-nitens* Schwein. in water, after 31 hrs. Put in drop culture next day after collection, May 19, 1892. × 333.

Fig. 14. Germination of uredospores of *Puccinia Hieracei* (Schum.) Mart. in water, after 24 hrs. Apr. 30, 1892. × 167.

Fig. 15. Germination of teleutospores of *Puccinia Redfieldiæ* Tracy, in water, after 46 hrs April 29, 1893, collected Oct. 1892. × 247. One mesospore is shown to be germinating.

Fig. 16. Germination of teleutospores of *Puccinia Phragmitis* (Schum.) Körn. in water, after 4 days, April 1893, collected Oct. 1892. × 247.

Fig. 17. Germination of teleutospores of *Uromyces Polygoni* (Pers.) Fuckel. in water, after 46 hrs. April 29, 1893, collected Oct. 1892. × 247.

Fig. 18. Germination of teleutospores of *Uromyces Sporoboli* Ell. & Ev. in water, after 48 hrs. Apr. 17, 1893. × 333.

Fig. 19. Germination of teleutospores of *Puccinia Sporoboli* Arth. in water, after 48 hrs. Apr. 17, 1893. *a*, sporidiola. × 247. Only the mesospores germinated, producing catenulate sporidiola.

Fig. 20. Germination of teleutospores of *Puccinia Grindeliæ* Pk. in water, after 20 hrs Apr. 24, 1893, collected Oct. 1892. Producing catenulate sporidiola. *a*. sporidiola. × 247.

Fig. 21. Germination of teleutospores of *Puccinia variolans* Hark.? of *Aplopappus spinulosus*, in water, after 19 hrs., producing catenulate sporidiola. *a*, terminal portions of promycelia, isolated, showing sporidiola in the process of abstricting. *aa*, sporidiola free. × 247.

Botanical notes from Bainbridge, Georgia. I.

AUGUST F. FOERSTE.

WITH PLATE XL.

Rootstocks penetrating the ground vertically.

Every one knows how roots penetrate the ground. The minute terminal rootlets find their way along crevices between the particles forming the earth, and the increasing bulk of the root pushes these particles aside. It is different with a rootstock. Its existence on germination begins near the surface of the ground and if it penetrates the ground vertically it must penetrate it backwards.

Where plants grow in marshy soil, as in the case of *Symplocarpus foetidus*, this is readily understood, but when the ground is more compact it is quite another matter. It must

especially be observed that the older the plant, the deeper the base of the rootstock will penetrate, and the broader it will become as a rule and hence the greater will be the direct resistance to be overcome. In many cases a more or less definite portion of the base of the rootstock dies every year. In that event the remaining portion of the rootstock must pass also through the space left by the decayed part, before it can sink its base to a still lower level.

It is difficult to understand how the broad base of a thick rootstock such as that of *Agave Virginica* L., for instance, or other still more striking instances, penetrate the hard ground. One thing I have noticed is that plants of this description usually have good stout vertical roots from year to year, and that these begin to wrinkle transversely towards the close of the season. Having a very good grip on the ground by means of the minor rootlets, the tension they exert on the rootstocks by their contraction in length must be enormous, but so must also be the resistance of the earth below the rootstocks. The only plausible explanation therefore seems to be, that the base of the rootstocks are able to force a passage slowly, little by little, when the ground is much softened by rains. This is a subject needing more investigation than has hitherto been given to it.

In this connection it was interesting to observe the habits of one of the palmetto palms, *Sabal Adansonii* Guerus. Here the rootstock is not drawn into the soil backwards but quite the reverse process takes place. In fact the initial narrow end of the rootstock is here directed upwards, and the later growth is formed along the rootstock deeper in the soil, so that a considerable part of the rootstock is pointed directly downwards, earthward, increasing in size in the same direction. At the lower thickened end, the tip of the rootstock is however bent abruptly to one side and then up until the tip itself points upwards. Strong roots are attached to the old rootstock and strong roots are also sent out at the just described strong bend below. It is evident that this curved portion straightens itself out at intervals, the roots drawing the successively newer and straightened portions down into the soil. In this way the base of the curved portion of the rootstock behind the tip is sometimes found at a level of considerably more than a foot beneath the level of the soil, from which level the rootstock must have started.

In the oldest plants the straightening out below the tip does not keep pace with the development of the axis about the tip, or its increase in length, so that the tip beyond this curvature is greatly thickened, producing a sort of tuberous rootstock. The general effect of this thickened end is that of the bowl of a short Dutch pipe, of which the older, longer end, tapering towards the initial extremity near the surface of the ground, represents part of the pipe-stem. The rootstocks of this palmetto may therefore be said to grow indirectly downwards into the soil, and they are not hauled down backwards as a whole, as is the case with so many other vertical rootstocks.

Notes on Leguminosae.

1. Changes in color of flowers.—The genus *Tephrosia* permits several interesting though not striking remarks on the changes of colors in flowers. *T. spicata* T. & G. has pure white flowers when fresh, turning purple on fading. *T. ambigua* Curtis has white flowers, the veins and the midrib of the keel, except toward the margins, being colored almost russet red. The flowers very soon became tinged light pink or rose, and on fading also turn purple. *T. hispidula* Pursh. is described as having purple flowers. It is evident that the chemical substances giving rise to the purple color are present in all these flowers, but they are differentiated at different times. In the first species this does not take place until the time of fading. In the second it has taken place in the veins when the flower opens, and soon begins in a mild way over the entire surface of the petals. In the last species the differentiation of this purple coloring matter has been completed before the flower blossoms.

It may perhaps also be inferred that this purple coloring matter (stable only under more vigorous conditions of the cells forming the petals) is due to the breaking up of previously existing chemical compounds, owing to a sort of process to disintegration or decay, since the change towards a purple color in the first two species takes place either at the time of fading, or at least is, in the second species, strongly accentuated at that time. The inflorescence consists of peduncled racemes, which are terminal. By the development of branches from the axils of the last leaf, a sympodial growth ensues, which in the case of *T. ambigua* may give rise to a number of

seemingly axillary peduncled racemes, which in reality, however, all terminate as many axes of growth.

2. *Flowers with the lower side turned up.* — Such an one is *Clitoria Mariana* L. The peduncle of the one- to three-flowered raceme is axillary and bears two minute opposite bracts at its base. In typical cases the lower flower pedicel on this raceme is subtended by three bracts of which the lateral ones represent stipules and the central one which is tripartite represents the subtending leaf. At the base of the pedicel are two opposite bracts equal in size to those last mentioned, so that five bracts cluster around its base. At the base of the calyx two similar opposite bracts occur, which structurally decussate with the lower pair, though owing to a twist of the pedicel through ninety degrees the last two pairs of bracts lie in the same plane.

This twist can easily be followed. Without it, the keel of the flower should structurally face laterally; following the general habit of Leguminosæ it should face downward, as a matter of fact however, and largely owing to the twist of the pedicel, it faces upwards and *the flower is thus turned with the lower side up.* The upper flower pedicel has, at its base, one bract to represent the subtending leaf, or a tripartite bract when solitary. Two more bracts, opposite to each other, occur at the base of this pedicel, two more occur as usual at the base of the calyx, and the intermediate pedicel is again twisted. *The tip of the axis of the raceme is aborted* and remains as a minute tip at one side of the base of the last pedicel.

Owing to the long tubular calyx and the broadly spreading habit of the vexillum the flower has a narrowly obovate appearance. The wings equal five-sixths the length of the vexillum, and the last two-fifths of the length is free from the keel, and is large and spreading. The keel is one-third the length of the vexillum. It is composed of two petals which are held together by a ridge near the inner margin of one petal with a deep groove along its outside and a corresponding infolded portion at the inner margin of the other petal, a little mucilaginous substance helping to keep them in place. The wings are free except near the middle of the expanded terminal portion of the side of the keel, where they are strongly pasted to the keel by a mucilaginous substance. The whole thus forms a case for the stamens and pistil, which is closed below (in a struc-

tural sense), and in front, but which above, is open for most of its extent, this portion of the case being held together only by the walls of the tubular calyx. Near the tip, however, the outer sides of the petals of the keel are strongly infolded, overlap, and are pasted together by a mucilaginous substance leaving only the acute tip free, as a passage for the terminal end of the style.

The stamens are diadelphous, the upper stamens being structurally free, though pasted to the inner sides of the lower monadelphous portion formed by the other nine stamens. The base of this tenth stamen is free for one millimeter to permit the escape of the honey formed by the horseshoe shaped gland at the base of the stamens within the tube.

The upper third of the stamen is also entirely free. The tenth stamen is held in position not only by the mucilage, but also by the fact that the sides of the slit tube formed by the remaining stamens are in a state of tension and press upon the tenth stamen, laterally springing back when loosened. The lower side of the flattened style is smooth, the upper side is hairy, as is also the stigma, especially along its upper margin. When visited by bees only the upper portion of the style appears above the tip of the keel, its upper hairy surface pushing out the pollen.

Centrosema Virginiana Benth. is so closely related as to have been described as a *Clitoria* by Willdenow. Its general habits are the same. Two bracts are found at the base of the peduncle and from the axils of these may arise one or two additional peduncles, also with two basal opposite bracts on each. All three peduncles have different times of flowering. At the base of the pedicels are three bracts representing the subtending leaf with its stipules, or an obovate bract with three teeth along the quadrangular apex, representing the same, or a single simple ovate bract, in which all three elements are probably united. The tripartite bracts subtend the lower, the rest the upper pedicels. The *two bracts* which in Clitoria occur at the base of the pedicels, *in Centrosema are united into a single large ovate bract* directly over the bract at the base of the pedicel. At the base of the calyx are two large ovate bracts a little shorter than the teeth of the calyx, and if the next lower bract were divided into two as it should be morphologically, then the bracts at the base of the calyx would decussate with the latter.

The pedicels are again twisted, so that the keel is turned upwards and the vexillum downwards. The calyx tube is 5^{mm} long, and its teeth extend 11^{mm} beyond the tube. The vexillum is large and orbicular. The wings almost equal the keel in size, the latter being about one-half to four-sevenths the length of the standard. The wings are appressed to the sides of the keel, following its curvature, and are pasted to the latter by a mucilaginous substance. The two petals of the keel are grown together along their (structurally) lower, inner sides, and, excepting at the base, also along their upper sides, which do not overlap, but meet along their edges. Perhaps the microscope might show that they were here held together along their thin edge by mucilage, but under an ordinary lens they seem to have actually grown together, though so weakly as to permit of separation with any moderately pointed instrument. At the apex of the keel the petals however remain free for a length of 4 or 5^{mm}, and through this slit both the upper part of the style and the stamens are protruded when the flower is visited by bees. This being the case there is no need of hairs along the flattened style to serve as a pollen brush and these are absent. The stigma however is hairy, the largest hairs being along the upper margin.

The upper stamen is *free* and on dissecting the flower is always found distant from the remaining stamens. The latter, of which there are nine, have their filaments united so as to form a tube, remaining structurally open along the top. Excepting at the very base however, and near the apex, the sides of this slit are pressed together, being under tension, so that there is formed a practically closed tube. The slit can be opened by means of any moderately pointed instrument. Perhaps the sides are a little grown together or held together by some mucilaginous substance. The terminal bud on the axis of the flowering raceme seems never to develop though the evidence is not so good as in *Clitoria*. In both *Clitoria* and *Centrosema* therefore, the pedicels are twisted and the flowers turned with the lower side up, so that the visiting insects, chiefly bees, and certain butterflies, receive the pollen on their backs, instead of on their sides and the lower part of their body, as is the case when ordinary *Leguminosæ* are visited.

There is still another papilionaceous plant which arrives at the same results, but in a different way. This is *Stylosanthes elatior*. It has "flowers of two kinds; one kind perfect

but sterile; the other destitute of calyx, corolla, and stamens, and fertile." The fertile flowers consist therefore solely of the legume; a leaflet with two adnate stipules subtends the same, and a pair of bracts is found at the base. The legume has a lateral position. On examining the perfect flowers, these and their legume are also seen to have a lateral position, so that it is impossible to say whether the fertile flowers always were destitute of other floral envelops and organs or not.

The lateral position of the legume is also the proper position for a pair of leaves belonging to the ovary, *directly* succeeding the bracts. The fertile flowers are the lower ones of the short spike. The sterile ones occupy the higher places.

The corolla is inserted at the summit of the constricted portion of the tube. This tube is erect. The standard is strongly reflexed so as to occupy a horizontal position. The keel rises above its plane, and arches forward over the standard. Any insect visiting this flower will therefore receive the pollen on its upper side.

The wings are attached to the keel by two moderately curved hooks; of these, the posterior one is situated at the base of the expanded portion, and is directed backwards, clasping over the inner edge of the free margins of the petals of the keel; the other is attached just above to the inner side of the wings, and is directed forwards, hooking into a corresponding deep depression at the base of the expanded portion of the keel. The petals of the keel are grown together below; above they are free, except the portion just behind the apex, where the *two inner sides* are applied to each other along a narrow margin, and are pasted together, face to face, or are moderately grown together. From the opening left at the apex of the keel, the tip of the barren style is usually exserted. When visited by insects the anthers are also pushed out, and the pollen is left on their heads. How from this place it reaches the recurved style of the fertile flowers below, except by dropping off, is a mystery. Perhaps the long, bristle like hairs on the subtending leaves and bracts serve as brushes. But even then it may be remarked that at least the earlier legumes seem already fertilized.

3. Inflorescences.—In the most complex case the peduncles of *Tephrosia* bear clusters of flowers, subtended by a bract. The next, a lateral pair of bracts, bear each a flower pedicel, without bracts. Immediately above the first bract mentioned

is another bract, in whose axil is a flower, without bracts; the bract belonging to this set, which should be found just in front of the peduncle behind the total inflorescence, is aborted. Next follow two lateral bracts above the first pair, each containing a flower, but in different stages of development. The terminal bud of the flowering axis must be either one of these two buds or be obsolete. The median plane of the flowers is vertical.

In the most complex case, the peduncles of *Lespedeza repens* T. & G., bear three or four alternating bracts, the successive ones more or less on opposite sides of the peduncle. Each of the bracts subtends an axis whose tip is aborted, but at whose base are a pair of lateral bracts, each subtending a flower. Consistent with this the apex of the peduncle is likewise aborted. Each flower pedicel bears a little below the calyx two bracts, and the median plane of the flower is vertical.

In *Rhynchosia tomentosa* T. & G., the inflorescences consist of short racemes in the axils of the upper leaves or tripartite bracts representing the leaves, or they are terminal. Whether the apex of these various racemes is aborted or not is unknown. The pedicels are subtended by bracts, but do not bear any themselves, and the median plane of the flowers is vertical. The ordinary plants bear leaves made up of these leaflets, but in the variety *monophylla* there is only one leaflet, though this shows its compound character by a joint near the upper end of the petiole, bearing the usual two minute scales.

Cassia obtusifolia L. has axillary racemes, of which the apex is aborted, and the members are confined to two opposite bracts near the base, subtending flowering pedicels. The latter, at their base, show each a small bract towards the front, the corresponding bract towards the rear against the stem being aborted, though a trace may sometimes be found in the form of hairy, horizontal lines. The median plane of the flower is vertical. A superposed bud occurs in the axils of many of the leaves, otherwise bearing the flowering axis.

Cassia Chamæcrista L. has axillary racemes, which are adnate, for a short distance above the axils, to the stem. The different flowering pedicels are subtended by bracts, and a little below the calyx are two bracts which, however, are distant from each other.

The above descriptions may suffice to show that the struc-

ture of the inflorescence of the *Leguminosæ* is quite variable. The inflorescences may be axillary, terminal, or pseudo-axillary only, owing to sympodial growth. The peduncles may or may not have a pair of opposite bracts at their base. The pedicels may have two pairs (of which one is then near the calyx), or one pair, or no pair of bracts at all, or two bracts may be grown together so as to form only one. The flowers may be in a lateral or in a vertical plane. The tip not infrequently can be proved to be aborted, which agrees with the general rule that *inflorescences composed of very irregular flowers usually do not develop flowers terminating the main axes*, and when such terminal flowers are developed contrary to the rule, these are not infrequently *regular* in form.

The reason why this should be so can of course be readily understood. In the process of forming irregular flowers out of regular ones, the bees and other insects visited chiefly the lateral ones which already were in a position to invite approach only from one direction. The upper terminal erect ones were then neglected and gradually became aborted.

4. Casting off of tips of branches.—Since the appearance of the later article on this subject a large *Mimosa* tree was noticed to have shed all the tips of its leaf branches late in May. The casting off of the tips in leguminous trees is quite normal. Indeed, it would be interesting to learn if there be *any* trees of that order which do form terminal scaly buds. Considering the frequency with which ligneous plants of this order shed their terminal leafy buds it may well be questioned whether the abortion of the terminal bud of the inflorescences of this family be not in large measure due to a general habit, instead of the special one following the above rule, according to which certain plants can be said to have no use for regular flowers, and terminal buds are only too apt to produce these. In this connection it may be of interest to refer to the case of *Apios tuberosa* Moench, described by the writer some years ago, in which the inflorescence, a compound panicle, first sheds the tip of the panicle with the attached racemes, and then sheds the upper flowers of all the remaining racemes, leaving the scars thus produced for extrafloral honey glands.

EXPLANATION OF PLATE XL.

Fig. 1. *Centrosema Virginiana*, Benth. Flower with the lower side turned up as in nature. Fig. 2. Same; side view of the bracts, sepals, wing, and keel. Fig. 3. *Clitoria Mariana* L. Flower with the lower side turned up as in nature.

Fig. 4. Same; side view of subtending bract-like leaf with its sepals, lower and upper bracts, calyx, wing, and a glimpse of the keel. Fig. 5. *Stylosanthes elatior* Swartz. Perfect, but infertile flower, furnishing only the pollen, a side view. Fig. 6. Female flower, consisting only of an ovary; the two bracts shown below. Fig, 7. *Œnothera linearis* Michx. with aberrant forms of petals. Bristol, Florida.

BRIEFER ARTICLES.

Bibliography of American botany.—The following circular has recently been sent to botanists and we desire to aid in giving it the widest publicity. See also editorial comment, p. 467.

"One item recommended by the Committee on Bibliography of the Madison Botanical Congress is an author catalogue of current works on American botany. To secure this Dr. N. L. Britton, editor of the *Bulletin of the Torrey Botanical Club*, kindly offered to change the monthly 'Index to literature relating to American botany' to the form recommended.

"Dr. Britton has experimented with details of form and typography and also, as planned, has experimented in reprinting the titles on regular index cards. He estimates that these cards will number nearly 1000 per year and that if the number of subscribers is sufficient, the series for 1894 can be supplied for five dollars.

"The cards will be of extra heavy linen ledger paper, accurately cut and the titles will be exact reprints of the matter that appears each month in the *Bulletin*, which will enable subscribers to keep the entire series in a single alphabet and to incorporate it with other indexes if they wish.

"This is the first step toward accomplishing the plans recommended by the Committee, and it is hoped that it will meet the approval and support of American botanists.

"Dr. Britton has asked the undersigned to take charge of subscriptions and the monthly distribution of the cards. It is important that we know very soon how many copies will be wanted. If you want it, kindly say so at once. If you can not subscribe now and think you may later, we need to know it. In any case please reply on enclosed postal. Samples inclosed.—CAMBRIDGE BOTANICAL SUPPLY CO., *Cambridge, Mass.*"

EDITORIAL.

OUR READERS will see by reference to a preceding page that one of the recommendations of the Committee on Bibliography which was approved by the Madison Botanical Congress is to be carried into effect at once. This is the publication of an author-catalogue of botanical papers relating to American botany. It has been of great advantage to botanists to have for reference the useful index to literature relating to American botany, which has been for several years a feature of the *Bulletin* of the Torrey Botanical Club. (We might take this opportunity, by the way, to express our pleasure that the doubts we possessed as to the permanence of this department at its inception have proved to be entirely unfounded.) This index is now to be made as complete as the co-operation of a number of specialists can make make it. What is of equal, if not of greater, importance is that the type already set up for this monthly index is to be used in printing the entries on index cards, and these cards are put on the market therefore at a cost far below what it would be if the matter had to be collated and printed separately.

IN THE PRODUCTION of this highly desirable result several factors have co-operated. In the first place, the editor who directs, and the members of the Torrey Botanical Club who support the *Bulletin* ought to receive the thanks of botanists. In the second place, even this first step would probably not have been taken had it not been for the Botanical Congress which briefly discussed the matter of bibliography last summer. For this Congress gave opportunity for the expression of approval which encouraged the editor of the *Bulletin* to preserve a department which he was tempted to abandon on account of the immense amount of work it entailed and the desirable space it occupied. It also gave occasion for the appointment of a committee on bibliography, in conference with whom Dr. Britton agreed to the typographical changes which have made the issuance of these cards possible. And finally, it is through the efforts of a member of this committee that the distribution and sale of the cards has been arranged with the Cambridge Botanical Supply Co.

The GAZETTE desires in every way to promote the success of this first venture which is the earnest, we trust, of yet more abundant harvests to be reaped through the cordial co-operation of generous-souled workers.

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THE WRITER in *Zoe*, "K. B.," who writes sneeringly of the botanical gatherings of the past summer appears sadly out of harmony with the spirit of the times among the botanists. Her envenomed pen stabs

chiefly at one, it is true. A more unscientific and unlovely spectacle it would be hard to find, than this disparagement of fifty or sixty other botanists because they choose to honor, however slightly, one whom she dislikes. Such bitter personalities only awaken compassion and stir regret; they are now-a-days unworthy of rejoinder.

CURRENT LITERATURE.

A Cuban text-book on botany.

An interesting phase of development of botanical teaching on this side of the Atlantic, is denoted by the recently issued text "Elementos de Botánica" part 1, by Dr. Juan Vilaró Diaz, of the University of Havana.

In a lengthy preface, Dr. de la Maza states that the work is called out by the want of a text in Spanish, and by the fact that foreign texts use, for illustration of plant phenomena, forms with which the Cuban student can not become familiar, and are otherwise unsuitable to accompany the courses of lectures in natural history offered in that University. Quite naturally he holds that the student can derive more practical advantage and general instruction from a study of the "forms that live in the beautiful climate of the magnificent Antilles."

The author divides the subject into static and dynamic botany. The volume just issued is concerned with the first, which it considers under the heads of cellulography, anatomy, morphology, embryology.

The relationship of the cell constituents is clearly outlined, and the author extends the text to include brief discussion of phases of the behavior and products of protoplasm, which do not usually find a place in elementary works. As an instance, under colors are paragraphs on pigments, origin and biological significance of colors, illumination, etiolation, protective colors, preventive colors, sexual colors typical colors, and attractive colors.

Throughout the entire work, forms and their relations are correlated with the more general functions of the organs in a manner that is very attractive. The economic relations of the plant are everywhere touched upon, and the author makes quite an excursion into the "tropisms," movements and carnivorous action. Under the latter head a cut and some interesting matter on the carnivorous action of Pinguicula, is taken from the U. S. Fish Commission report for 1885.

It could not be expected that the author of a pioneer text in such a musical language, would deny himself the privilege of introducing some new terms into our hazy terminology. He has, however, but

sparingly availed himself of the privilege so far, a self-denial it is hoped he will be able to sustain in the second part now in preparation, on physiology. In the present volume he introduces three terms coined by Dr. de la Maza, viz., *embriobroma*, the albumen of the seed, *embriobroma nucleogénito*, the perisperm of Schleiden, *embriobroma saccagénito*, the endosperm of Schleiden.

The breadth of thought, arrangement of matter, free compilation and simple direct style of the writer go to make up a text, that can but awaken enthusiasm among the students for whom it is intended. In conjunction with the high grade of teaching which the author represents, it will carry such inspiration, that we may hope soon to see a group of earnest workers at the University of Havana, who amid the rich flora of this tropical region, may accomplish much, especially in the domain of plant ecology.

The text is largely adapted after van Tieghem, the illustrations are from drawings by the author, Sachs, Reinke, and others. The publishers have done scant justice in this matter, while the usefulness of the book is materially lessened by the absence of a table of contents. It is but proper to say, however, that the book has some features that could be introduced into American texts to their distinct improvement.—D. T. MacDougal.

Recreations in botany.

Our readers will bear us witness that we have cordially welcomed every attempt to restate the more recondite matters of botany in such fashion as to render them more easily understood and more interesting to those who were not botanists. If we have occasion to criticise severely some attempts in this direction, it is because they are made without the scientific knowledge and literary ability which are the precedent conditions to successful popularizing of botany. We again express the hope that some of our well-trained botanists will devote a little of their time and energy to the popular exposition of the science. They owe this to their day and generation. The book before us is an attempt to do a desirable thing, for which the author deserves praise, but it is to be regretted that she was so poorly equipped for the task. The text of these "recreations in botany"[1] appeared first as a series of articles in *Harper's Bazar*. It is a pity that some good friend of the writer did not advise her to let them die with that ephemeral life, rather than permit rejuvenescence in the form of a book. More or less pertinent illustrations have been gathered from the storage vaults

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[1] Creevey, Caroline A.—Recreations in botany. Small 8vo. pp. xiv+216. figs. 61. New York: Harper & Bros. 1893.

of the Messrs. Harper, and some decidedly original ones added by the author. The latter, and some of the others are crude, ill-drawn, and even grotesque caricatures of what is intended, made all the worse looking by comparison with the graceful and artistic work of Hamilton Gibson and Alfred Parsons.

The writer is evidently a lover of flowers and familiar with many of the flowering plants of the Atlantic region. In chapters relating to these she is at her best; but when she turns to physiology or to the lower plants, she writes a sorry mixture of fact and fancy. Even her facts seem to have been put into a kneading machine and thoroughly incorporated; and they are fed out often without the least reference to their relations.

Some of the opening sentences of the book are calculated to give a botanist cold shudders. Witness: "The pursuit of botany ought to be ranked as an outdoor sport." "For (and this is one of the points I wish to emphasize) botany is the easiest of all the sciences and can be engaged in without a teacher." Which she has too evidently done.

The chapter on plant movements furnishes some queer information: "The boat-shaped desmids and diatoms jerk themselves over considerable distances. The cilia (hair-like processes) of some mosses move about in water. Oscillaria are curious one-celled plants, which, under the microscope, look and wriggle like angle-worms." But it is when the cryptogams are reached that the author flounders most hopelessly. These plants, she says, "possess this advantage over our garden plants, that many of them can be studied in winter." "In such plants the sap does not circulate, but water passes freely though the cell walls." "Azolla looks like a creeping moss or liverwort." "Being small, many of them invisible to the naked eye, they [mosses] do not need a fibrous skeleton." In the scale-mosses "mixed with the spores are elaters, called macrospores." "The scale-mosses under a microscope look like lizards or curiously shaped reptiles." Speaking of the lichens she says, "the gonidia, a layer of green cells in the thallus, under a transparent cover called the hypha, divide each one into two, and form new plants. They are parasitic upon the lower layer of the thallus."

The algæ seem to be if possible less understood by the author than other groups. Speaking of algæ in general, "the spores," she says, "have a tendency to divide into four parts and are called tetraspores. They are provided with cilia either in pairs or all around their ball-shaped bodies. . . . Each cell seems capable of propagating two new plants by division. Another remarkable means of propagation is by 'conjugation'." "Many algæ are edible. The dulse of the Scotch

and the tangle of the Swede are made from algæ." "Zygnemas are composed of long tubes joined together by short ones, all marked with beautiful spirals or crosses, or other regular figures. They are large confervæ, and are found in great numbers fifteen thousand feet up the Himalayas, in the cold springs which rise from the glaciers." "The famous red-snow . . . is a cell containing starch and nitrogen; in other words protoplasm. . . . An allied alga is the *Pamella* (sic) *cruenta*, deep red in color, found on stale bread and meat, or upon musty walls of houses."

We cannot forbear one further quotation, since these are more for the delectation of our readers than as a justification of our criticism. "The ferment-mould inhabits liquids—wines, ciders, vinegars, and the like. The story is told of a man who placed his cask of wine in the cellar to age. Some time afterwards, when he attempted to open the cellar-door, it was blocked by great growths of fungus. The cellar was literally filled with the fungus, which had reveled in the wine leaking from the cask. The empty cask was lifted on top of the fungoid growth to the ceiling. This is the famous fungus found in the London docks, swinging and waving like gigantic cobwebs."

Miss (or is it Mrs.?) Creevey declares, at the end of her book, that "the object of the foregoing chapters has been, not a scientific treatise on botany, but to show how comparatively simple and easy it is, and what a pleasure it is, to know something—a great deal—about plants." This naiveté recalls the apt rebuke of an American humorist, "It's better not to kno so menny things than to kno so menny things that ain't so."

It would have been better for the author (and for the world) if she had not been so impressed with the idea that "it is as a recreation, a summer amusement, that the pursuit of botany is earnestly recommended." We recommend her to suppress this book and to give her undivided attention to botany for a series of years before she again ventures to popularize it.

It is not so remarkable that ignorance and confusion of ideas should exist; it is amazing that they should so frequently get into type. We are surprised that the Messrs. Harper would allow such a publication to bear their imprint.

OPEN LETTERS.

The botanic annual.

In the October issue of the GAZETTE Mr. W. T. Swingle presents a number of remarks on the idea of having an annual report on American botanical literature. The outcome of Mr. Swingle's consideration

is that *no* such publication should be made. As I was one who declared himself willing to work, when the GAZETTE had said a great deal about the desirability of a work this kind, I shall try to show that it is not for my personal pleasure that I did so. When I *was asked* to present my idea in the GAZETTE, and, afterwards, in Madison brought up the matter again, I thought that the GAZETTE had laid the foundation, viz., showed reasons for publishing an annual or yearly list of botanical publications. From the the last article which causes these lines to appear, I understand that Mr. Swingle wishes either no annual at all, or one published in German or French.

The *Botanischer Jahresbericht* cannot be relieved from the charge of neglect. A work of this kind, one of the most expensive periodicals ever seen in our line of work, ought to rely upon the books and papers which could be bought or otherwise promptly secured, and not only upon donations. It should obtain everything published, so that a "nicht gesehen" never could be alleged. If the writer undertook to compile all the literature on vegetable physiology—as, in fact, he has - he would be badly off if he indexed only such papers as he could conveniently lay his hands on, and presented that as the literature "aller Länder." But it must be admitted that it is extremely difficult to get hold of even the titles.

What we need, are *complete* bibliographies in our science, and this first of all. It is quite true that American publications are difficult to obtain in Europe, and here, of course, the booksellers have the responsibility, either in the way of not having the means of procuring the books, or putting too high prices on them if they have them.

I always thought that German, English, and French were the three main languages of the globe. Mr. Swingle, himself, thinks that if a botanist can not read all of these, he "ought to give up his business." Therefore, every botanist ought to be able to read the annual in English. From this to Japanese is a large gulf; nobody would publish such an annual in Japanese, unless joking. But if it were to be published in German, how many English students would be able to read it then? Not many. French would give a worse result.

Two publishers are still willing to take the annual. I repeat this, since it was not believed, as a *fact.* Such annuals as the one proposed are generally well received, when complete. The *Repertorium annuum botan. period.* by Bohnensieg and Burck, if it had had good backing, would have been more useful than the *Jahresbericht* is; it contained complete lists of references, while Just's (or rather his successors') work is in many regards incomplete. It would not matter if ten different annuals in the three most important languages of the world were published, if those ten volumes gave *complete* lists of literature and *objective reviews.* Botanists who wish to see, year by year, what appears in the literature on the subject of their specialty, would more gladly go through these ten volumes and find everything, than they would consult the *Jahresbericht* alone and find a part of it.

I have great regard for Mr. Swingle's objections, therefore I tried to meet all of them. The GAZETTE deemed the subject an important one, therefore I hope to be pardoned for discussing it at length.—J. CHRISTIAN BAY, *Bacteriologist of the Iowa State Board of Health, Ames, Iowa.*

NOTES AND NEWS.

DR. OSKAR LOEW of the University of Munich has been called to the University of Tokio as professor of agricultural chemistry.

REV. C. F. MAXWELL, of Dublin, Texas, is engaged on drawings of the oaks of western Texas which he expects to publish next summer after the style of Kellogg's West American Oaks.

THE PAPERS AND DISCUSSIONS before the Society for the Promotion of Agricultural Science at its Madison meeting occupy the larger part of the Aug.-Sept. number of Agricultural Science.

DR. GEORG DRAGENDORFF, author of the well known work on "Plant Analysis," and professor of pharmacy in the University of Dorpat, Russia, has resigned his position and removed to Bern, Switzerland.

PROF. DR. P. SORAUER resigned, October first, the directorship of the Experiment Station for Vegetable Physiology at Proskau, Germany, and Dr. Rudolf Aderhold of Geisenheim has been appointed his successor.

DR. GEO. E. STONE, who has been studying abroad, especially in Prof. Pfeffer's laboratory at Leipzig, has been appointed assistant professsor of botany in the Massachusetts Agricultural College at Amherst. He will give particular attention to physiological botany.

THE OBJECT AND METHODS of seed investigation and the establishment of seed control stations are carefully and ably treated by Dr. Oscar Burchard of Hamburg, Germany, in the *Experiment Station Record* (IV, 793–801, 882–900). The article contains very full information, and is well illustrated.

THE SIXTH ANNUAL REPORT (1892–3) of the Scientific Station for Brewing in Chicago, shows a remarkably large amount of work accomplished. In the bacteriological department, in charge of Mr. A. Lasché, examination was made of 1059 samples of yeast, 1105 of beer, and 280 of water. The results are instructive to others beside those engaged in the brewing industry.

IN A RECENT NUMBER of *Studies from the biological laboratory* of Johns Hopkins University (vol. v, Oct. 1893) Dr. J. P. Lotsy presents some facts regarding the structure of cypress knees, claiming to have found fungous spores present and occasional mycelium, and Mr. B. W. Barton describes and illustrates the origin and development of the stichidia and tetrasporangia in Dasya elegans.

THE FOLLOWING NEW BOOKS have been announced for early publication: "Handbook of systematic botany," by E. Warming, translated from the Swedish by M. C. Potter, from the press of Swan Sonnenschein & Co.; "Practical physiology of plants," by F. Darwin and E. H. Acton, from the Cambridge University press; "A student's textbook on botany," by Sidney H. Vines, copiously illustrated.

IN THE ANNUAL report of the Vermont Experiment Station for 1892 is some interesting matter upon plant diseases, especially of the potato, oats, apple, cucumber and lettuce, by L. R. Jones. In the simi-

lar report of the Wisconsin Station for 1892 is an illustrated article by F. H. King on the natural distribution of roots in field soils, containing important additions to our knowledge of the rooting habits of plants, and articles by E. S. Goff upon use of fungicides, and the deterioration of the natural vigor of strawberry plants through the continued action of spot disease (Ramularia Tulasnei). The latter points out a danger to the successful growing of crops that has not yet been sufficiently well recognized.

AMONG RECENT station bulletins are the following having botanical interest: "Colorado weeds," by C. S. Crandall (Colo. no. 23). Beside some general observations nine kinds of weeds are described and figured; three of the kinds are illustrated both from pen sketches and photographs, and it is very noticeable that the former method is adapted to show more detail of structure, and the latter to better present the habit of the plant. "Loco and larkspur," by David O'Brine (Colo. no. 25), is an interesting subject, which receives preliminary treatment from the chemist's and physiologist's standpoint, with the tentative conclusion that those species of Astragalus and related plants called loco weeds are not responsible for the loco disease. L. H. Pammel and F. C. Stewart (Iowa no. 21), write, the former upon bacteria connected with the dairy, and the latter upon the impurities of clover seed.

MR. HENRY L. CLARKE, of the University of Chicago, in the *American Naturalist* for September, publishes a paper on "The philosophy of flower seasons", which suggests a very interesting field of research. The field is suggested in somewhat shadowy outline, and the illustrations used are meant to be of the most general kind. After passing in review the large groups as represented in the "Manual range", and pointing out their season of blooming, the general deduction is made that "from early spring to late autumn there is a progression in the general character of the flower-groups, from the lower to the higher, successive groups succeeding each other in time, parallel groups coming synchronously." Various modifying conditions are mentioned, such as the necessities of pollination.

THE DATES of publication of the parts of Torrey & Gray's "Flora of North America" and Hooker & Arnott's "Botany of Beechey's Voyage" have been published by Mr. B. Daydon Jackson in *Journal of Botany* (October) as follows: *Flora of North America*, Vol. I, Part 1 (pp 1–184), July, 1838; Part 2 (pp. 185–360), October, 1838; Part 3 (pp. 361–544), June, 1840; Part 4 (pp. 545–698), and Errata, June, 1840: *Botany of Beechey's Voyage*, Part 1 (pp. 1–48), 1830; Parts 2 and 3 (pp. 49–144), 1832; Part 4 (pp. 145–192), 1833; Part 5 (pp. 193–240), 1836; Part 6 (pp. 241–288), no indication of date; Parts 7 and 8 (pp. 289–384), 1840; Parts 9 and 10 (pp. 385–486), 1841. In the case of the *Botany Beechey* the dates are obtained from those of the new genera as given in Pfeiffer's *Nomenclator;* and hence the date of Part 6, containing no new genera, is left with no clue.

GENERAL INDEX.

***The more important classified entries will be found under the following heads: *Diseases, Floras, Journals, Personals, Reviews.*

*** Names of synonyms are printed in *Italics;* names of new species in **bold face;** * signifies death.

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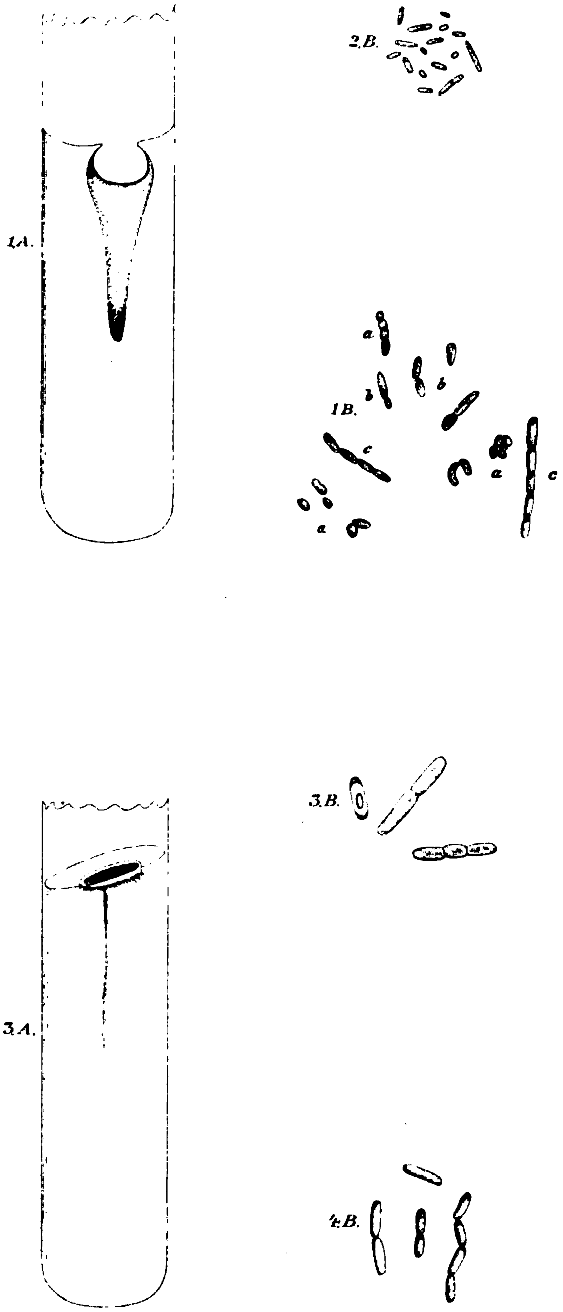
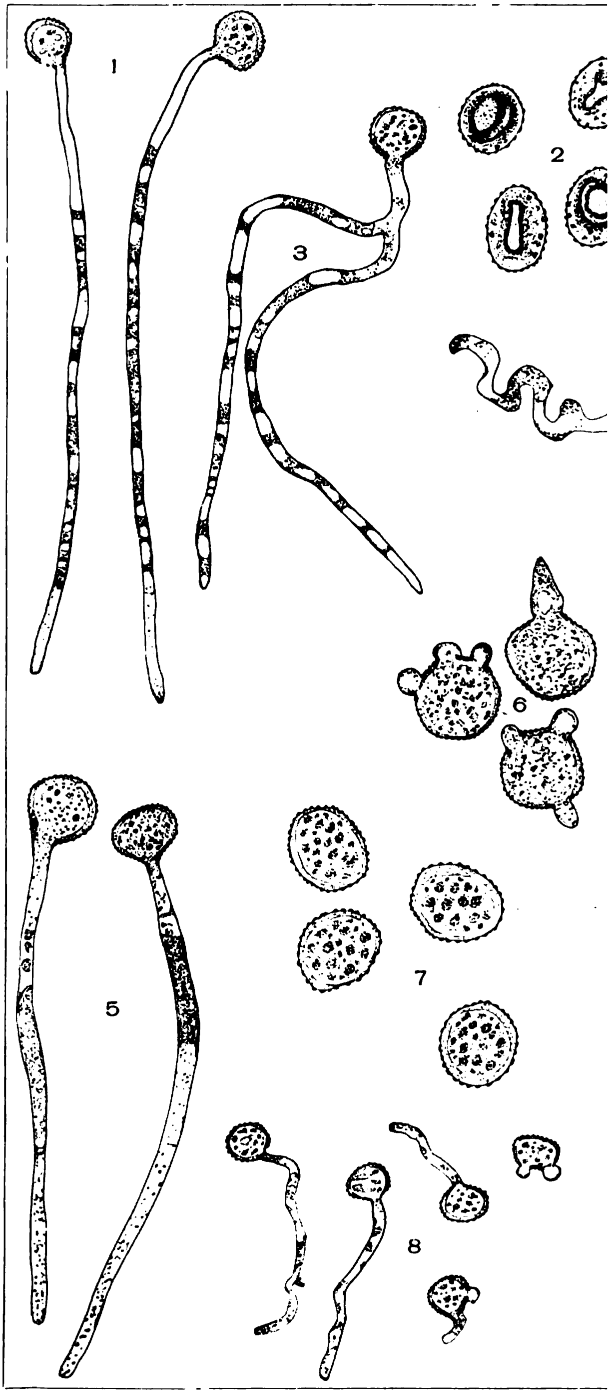


J. G. A., del.

RUSSELL ON BACTERIAL FLORA OF ATL



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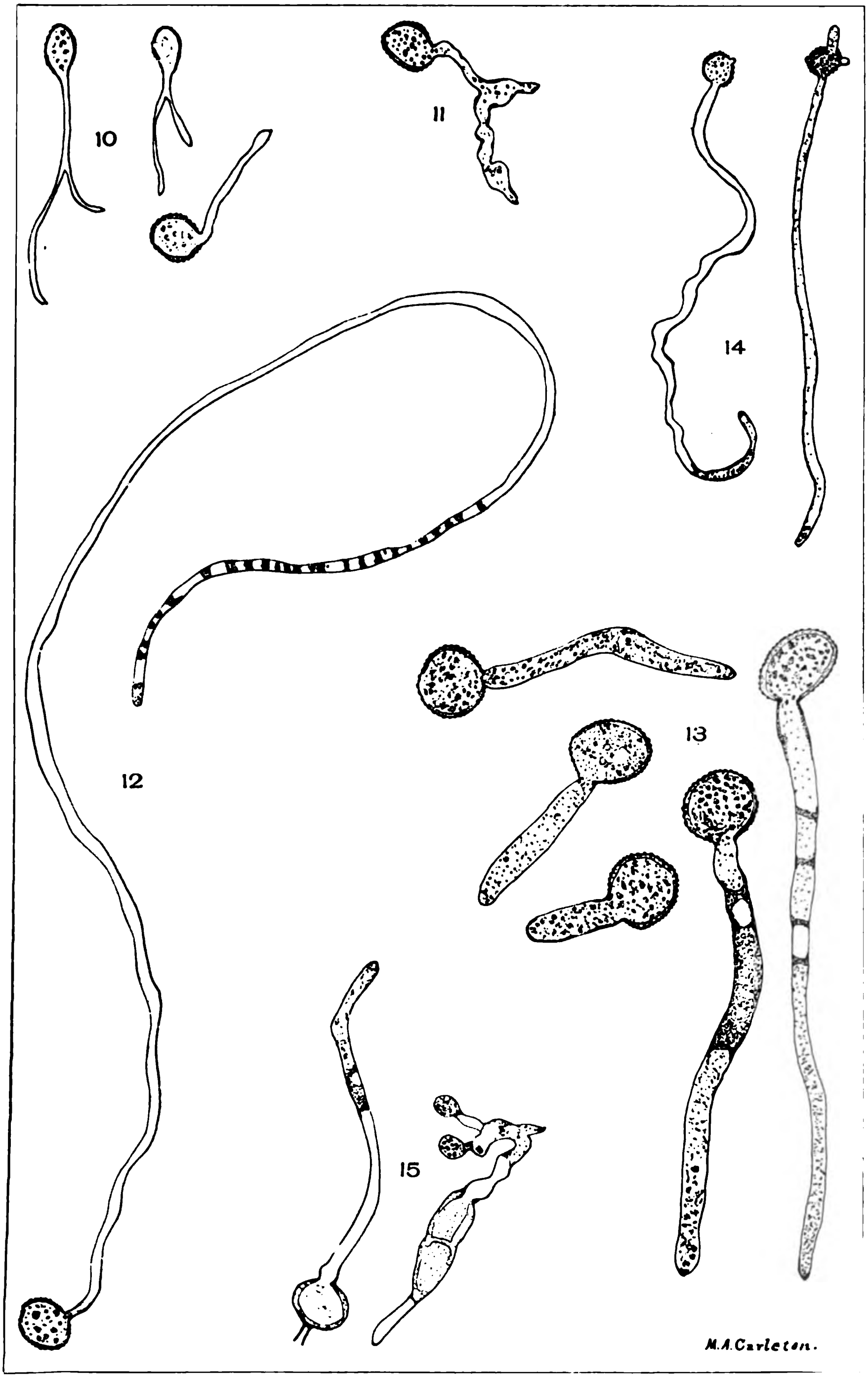

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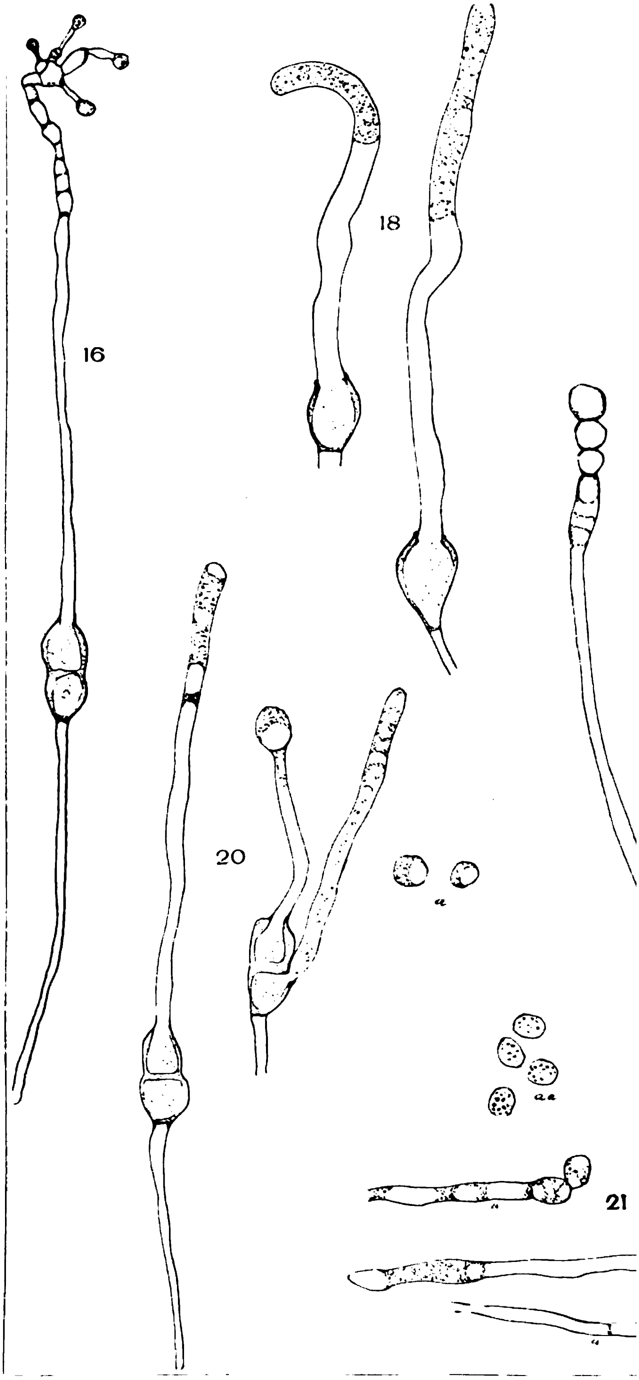

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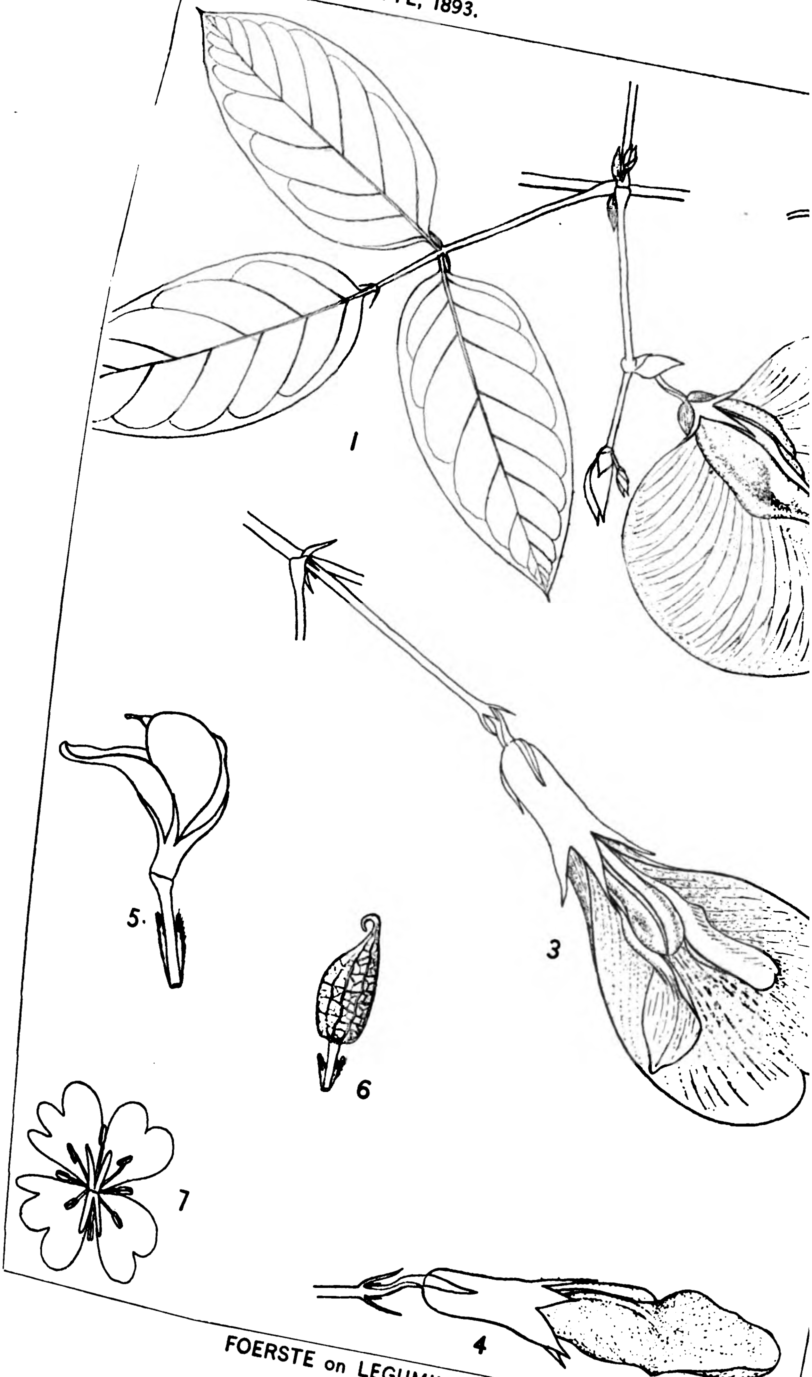

FOERSTE on LEGUMINOSÆ.